# MULTI-MEDIA DETAILED GEOCHEMICAL STUDY

# OF THE YAVA LEAD DEPOSIT (EAST ZONE)

# CAPE BRETON COUNTY, NOVA SCOTIA

NOVA SCOTIA DEPARTMENT OF NATURAL RESOURCES
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# ABSTRACT

A detailed multi-media geochemical study was conducted over the east zone of the Yava lead deposit of southeastern Cape Breton Island during the 1990 field season. A 2 x 2 km grid was centred over the projected subcrop of the east ore zone and sample sites were located at 250 m spacing. Samples collected at each site included: (1) Balsam fir (Abies balsamea) and/or black spruce (Picea mariana) depending upon species availability; (2) $A_1$ horizon (organic humus) soil layer; and (3) unweathered(?) till taken below the B soil horizon. In addition, stream sediment samples were collected at approximately 250 m spacing along a first- and second-order stream that crosses the grid.

An overburden drilling program was undertaken in conjunction with the grid survey. The purpose of this study was to investigate the glacial stratigraphy in the vicinity of the Yava deposit. Logs are presented for the three completed drill holes. Analysis of several till clasts from these drill holes returned high concentrations of Pb (often >1%) and one sample returned 2.56% Pb and 2.65% Zn. Results of the overburden study indicate that the ice flow direction in the two main till sheets was toward the northeast.

Several media were submitted for multi-element analysis by the Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) method. These include: (1) -230 mesh (-62.5$\mu$m) fraction of till and stream sediment samples; (2) non-magnetic heavy mineral separates from the -60+230 mesh (-250+62.5 $\mu$m) fraction of till and stream sediment samples; (3) ashed Balsam fir; and (4) -80 fraction of $A_1$ soil horizon. Analytical results are presented in a series of tables. Selected trend surface plots are presented for the grid data and selected plots are displayed for the stream data.

Our data indicate that the Yava deposit has a robust geochemical signature, mostly involving Pb and Zn, that clearly defines the subcrop of the east ore zone in most sample media. The relative distribution of Cu, Cd, Ag, Ba, Fe, As and Sb varies substantially between sample media and each element may or may not reflect the location of the subcrop of the ore zone.

The -80 mesh (-177 $\mu$m) fraction from organic humus (i.e. "A" soil horizon) delineated enrichments in both Pb and Zn, although these enriched zones were displaced from the subcropping ore zone. The Pb- and Zn-enriched zones in both till and Balsam fir were not displaced, therefore, it appears that the humus samples were more susceptible to hydromorphic dispersion and should not be included in future exploration programmes.

From the perspective of cost-effectiveness, biogeochemical sampling of Balsam Fir twigs is the best method for geochemical exploration for Yava-type deposits in the Carboniferous basins of southeastern Cape Breton Island. Biogeochemical sampling can be completed quickly. Individual samples are rather bulky but lightweight and sample preparation procedures are relatively uncomplicated and cost-effective and do not involve numerous ste ps where the sample could become contaminated.

The chief disadvantage with biogeochemical surveys is the deficiency of information regarding the underlying till. A sound understanding of the glacial geology is of paramount importance when interpreting the observed geochemical signatures. For example the identification of till clasts yields insight into till provenance, ice-flow direction(s) and dispersion distance of individual till sheets. The main drawback with till sampling is that it

is both time-consuming and it employs costly sample preparation procedures.

We recommend that a composite survey is the best method for discovering new "Yava-type" deposits in eastern Cape Breton Island. The first step is to sample all of the 1st°, 2nd° and 3rd° streams in the survey area using a 2 km spacing. The analysis of the -230 mesh (-62.5$\mu$m) fraction of collected samples will pin-point any Pb or Zn anomalies. The use of heavy mineral separates from the -60+230 mesh (-250+62.5 $\mu$m) fraction of streams will not contribute substantially to the information base and can be eliminated. All "anomalous" streams should then be sampled in detail at 250 m spacing to define the point where the anomalous elemental concentrations enter the stream. Following the stream sediment survey, areas that are not properly intersected by good drainage systems and areas surrounding anomalous stream sediment samples should be grid sampled using a combination of biogeochemical and till sampling techniques. Biogeochemical sampling of Balsam Fir and/or black spruce twigs depending upon species availability should be completed on 250 m grid spacing. Till samples should be collected at regular intervals, for example 500 m grid spacing, throughout the survey areas. This will ensure sufficient information regarding the glacial geology and optimize the speed and cost-effectiveness of the survey.

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# 1 PROJECT OUTLINE AND INTRODUCTION

The prerequisite for any exploration geochemical survey is the estimation of the geochemical response of mineral deposits in the specific physiographic terrane(s) to be surveyed. This is normally accomplished by orientation or detailed surveys designed to "determine the optimum field, analytical and interpretive parameters which can distinguish an anomaly from background" (Levinson, 1974). The Nova Scotia Department of Natural Resources (formerly Mines and Energy) and the Geological Survey of Canada have conducted 13 separate geochemical surveys in Nova Scotia since 1957 (Rogers and Lombard, 1990). However, only limited orientation surveys have been performed for biogeochemical (Fortescue and Hornbrook, 1969; Brooks et al., 1981), stream sediment (Rogers and MacDonald, 1984a; Rogers and Mills, 1986) and glacial till (DiLabio, 1982; MacEachern and Stea, 1985) sample media. Consequently, the follow-up geochemistry project was initiated as part of the 1990-1992 Canada-Nova Scotia Cooperation Agreement on Mineral Development. The objectives of the project are to: (1) establish the geochemical signature or "fingerprint" of various mineral occurrences throughout Nova Scotia; (2) evaluate the relative effectiveness of various geochemical techniques, including cost; (3) present information that will assist in the interpretation of data from "regional" surveys. This report outlines the results of a study conducted at the Yava lead deposit (Lat. 45° 52' Long. 60° 24') during the 1990 field season.

Detailed geochemical surveys may employ several sampling media including bedrock, till, "B" horizon soil, "A" horizon humus, biogeochemical (i.e. trees and shrubs) and stream sediments or waters. The specific choice of media is determined by the relative availability in the potential survey area. Detailed surveys also typically employ multiple sample preparation procedures, for example various size fractions and/or heavy mineral concentrates may be extracted from stream, till or soil samples. Detailed surveys may also experiment with the relative sensitivity, accuracy and precision of various analytical procedures bearing in mind the type of mineral deposit to be studied. Survey results are used to establish the most efficient and cost effective methods for conducting larger scale surveys.

Several criteria should be considered when selecting a deposit for study. An understanding of the geological setting including the host rock(s), factors controlling mineralization and the essential ore mineralogy and geochemistry of the deposit is essential. It is preferable that the deposit be of economic importance although smaller occurrences can be used. The deposit should subcrop or outcrop such that secondary (i.e. surficial) dispersion has occurred. A fundamental understanding of the glacial geology, including the stratigraphy, provenance and ice flow direction of individual till sheets, if more than one is present, is preferable. Contamination from mining or other human activities must be minimal, such that the natural geochemical pattern or fingerprint can be determined. Lastly, the physiography and geological setting around the deposit must be representative of all, or a portion, of the regional survey area.

## 2 YAVA Pb DEPOSIT

### 2.1 Regional geology

The Yava Pb deposit is situated along the southeast flank of the Carboniferous Glengarry Half Graben (GHG) of southeastern Cape Breton Island. The GHG (125 km$^2$) is wedge-shaped with a northeast-trending synclinal axis (Fig. 1). The GHG is fault bounded with Hadrynian to Ordovician volcanic, sedimentary and intrusive rocks along its northwestern margin. Conversely, it unconformably overlies a heterogeneous basement composed of Devonian rhyolite porphyry of the Loch Lomond Plutonic Complex and Hadrynian to Ordovician mixed sedimentary and volcanic rocks along its southeastern perimeter (Fig. 2; Barr et al., 1984). The GHG is fault bounded, along its southwestern edge, with Carboniferous sedimentary rocks of the contiguous Loch Lomond Basin (LLB).

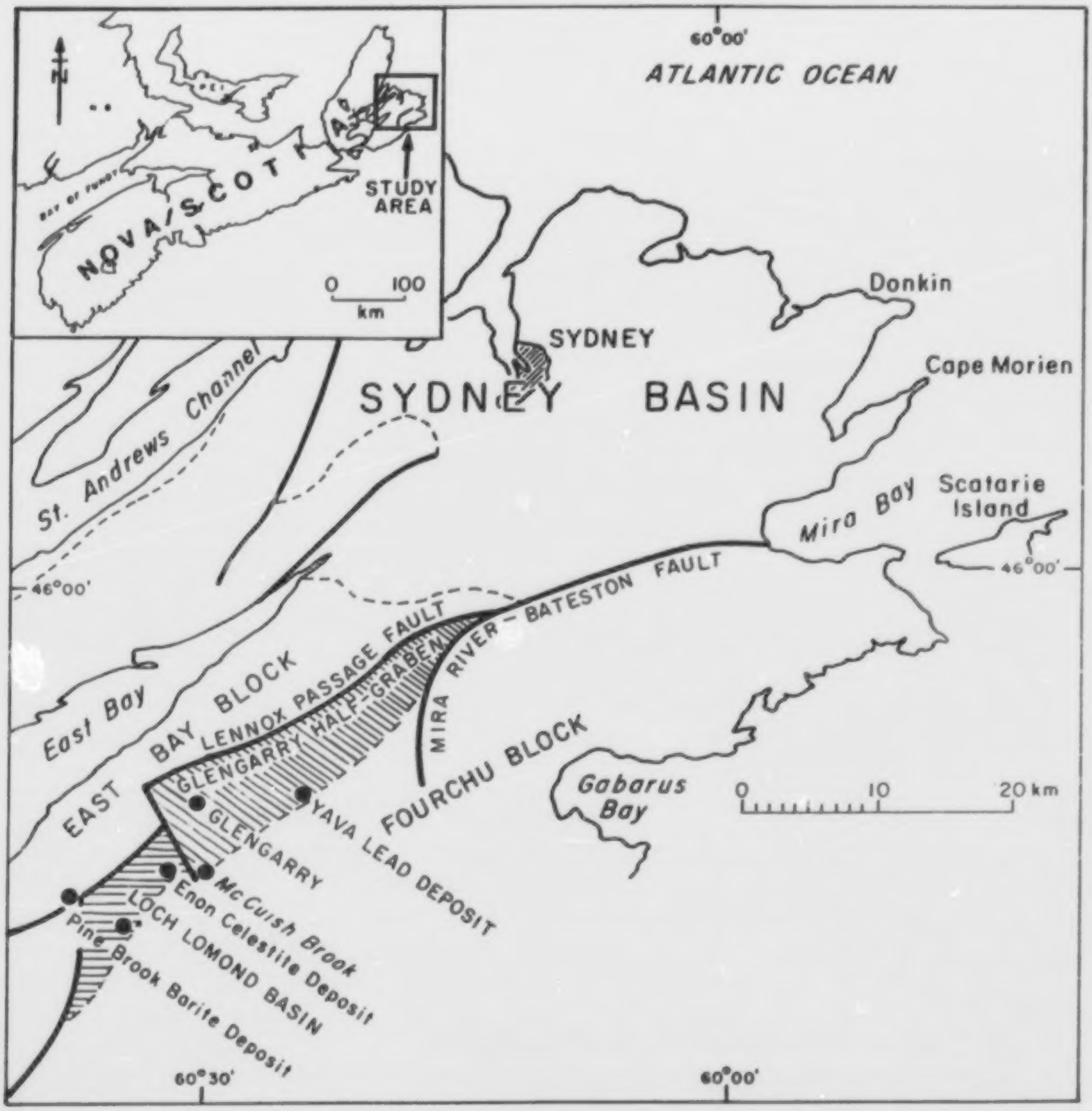
Geological mapping of the GHG (Prime and Boehner, 1984; Boehner and Prime, 1985) indicated that it consisted of a conformable sequence of Namurian to Late Wesphalian aged continental siliciclastics that unconformably overly Visean aged interstratified carbonates, siliciclastics and evaporites (gypsum and anhydrite) of the Windsor and Mabou (Canso) Groups.

### 2.2 Mineral potential

Lead occurrences in the Silver Mine (i.e. Yava) area were first discovered in the late 1800's (Bonham, 1982). Intensive exploration by numerous companies, including Talisman, Gunnex, Phelps-Dodge, Amax, Panarroya, Cominco, Cuvier and Esso, between 1960 and 1980 led to the discovery of numerous additional occurrences and prospects within the GHG and adjoining LLB. The mineralization can be grouped into two major types. The first group includes stratabound, sandstone-hosted Pb and/or Zn sulphide deposits that are restricted to the basal part of the coarse clastic Silver Mine Formation directly over the basement unconformity (e.g. Yava deposit; Figs. 2,3 and 4) or where the Silver Mine has been deposited into erosional depressions in the underlying Windsor group (e.g. Terra Nova deposit; Fig. 2).

The second type includes strataform (stratabound?) carbonate-hosted Sr, Ba, Cu-Pb-Zn or Fe,Mn deposits that are found mostly in the Enon Loch Lomond and Uist formations of the Windsor group. These deposits are generally restricted to the basal part of these units directly over basement unconformities. Examples include the Lake Enon Celestite (Sr), Pine Brook Barite (Ba) and McCuish Brook (Mn,Fe) deposits (Figs. 2 and 4; Prime and Boehner, 1984).

Genetic models for the formation of mineral deposits in the Glengarry and Loch Lomond basins range from syngenetic to diagenetic for most sandstone-hosted and some carbonate-hosted deposits, to "sed-ex"/replacement for some of the vein-type carbonate-hosted deposits. The diagenetic models generally involve the downward migration of meteoric (?) fluids,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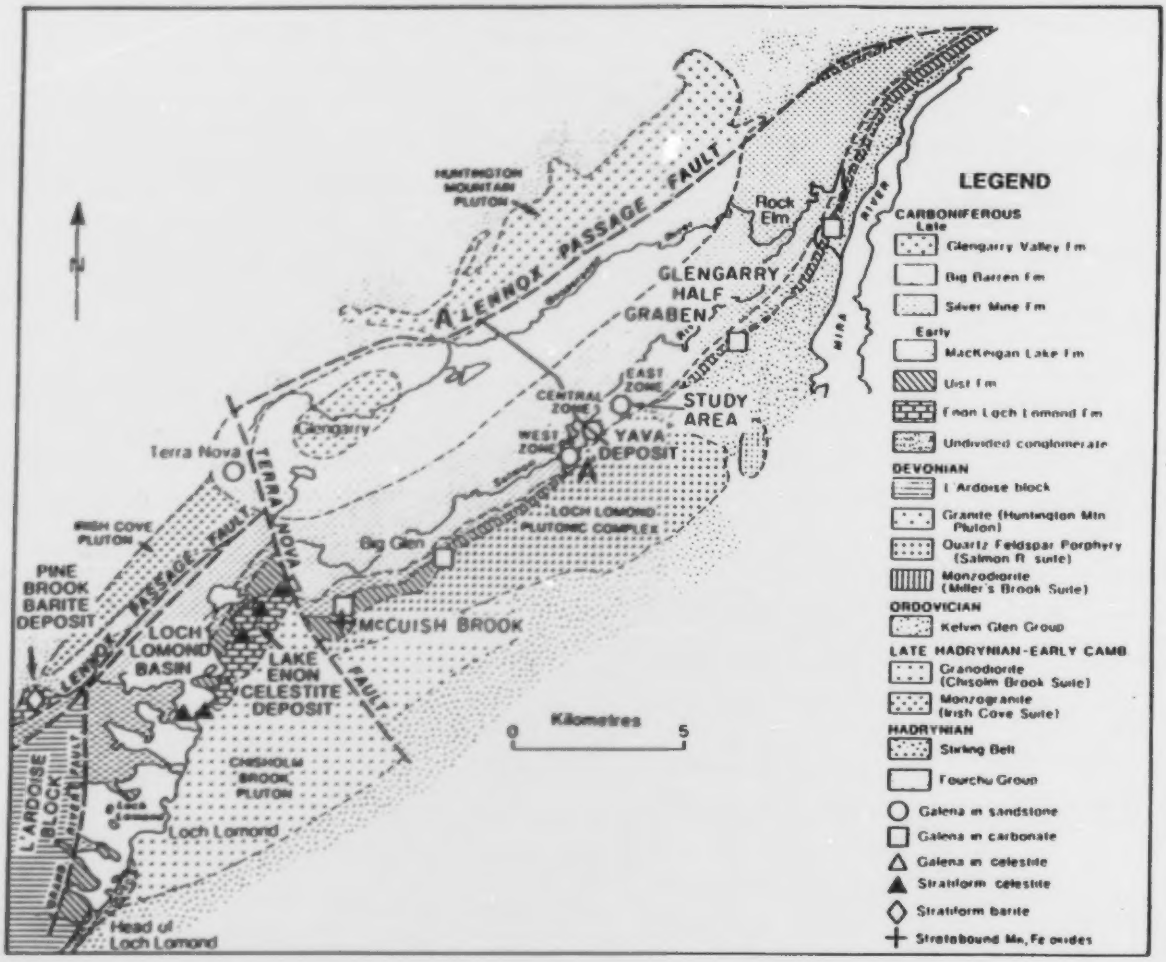
LENNOX PASSAGE FAULT
GLENGARRY HALF-GRABEN
East Bay
EAST BAY BLOCK
FOURCHU BLOCK
Gabarus Bay
0 10 20 km
GLENGARRY
YAVA LEAD DEPOSIT
McCuish Brook
Enon Celestite Deposit
LOCH LOMOND BASIN
Pine Brook Barite Deposit
60°30'
60°00'

Figure 1. Location of Yava Deposit, Glengarry Half Graben (inclined lines) and Loch Lomond Basin (horizontal lines), southeastern Cape Breton Island, Nova Scotia (modified from Prime and Boehner, 1984).


HUNTINGTON MOUNTAIN PLUTON
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TERRA NOVA FAULT
CENTRAL ZONE
EAST ZONE
STUDY AREA
WEST ZONE
YAVA DEPOSIT
A
LOCH LOMOND PLUTONIC COMPLEX
IRISH COVE PLUTON
Big Glen
PINE BROOK BARITE DEPOSIT
LENNOX PASSAGE FAULT
LOCH LOMOND BASIN
LAKE ENON CELESTITE DEPOSIT
McCUISH BROOK
Kilometres
0
5
L'ARDOISE BLOCK
CHISHOLM BROOK PLUTON
Loch Lomond
Head of Loch Lomond
LEGEND
CARBONIFEROUS
Late
Glengarry Valley Fm
Big Barren Fm
Silver Mine Fm
Early
MacKeigan Lake Fm
Uist Fm
Enon Loch Lomond Fm
Undivided conglomerate
DEVONIAN
L'Ardoise block
Granite (Huntington Mtn Pluton)
Quartz Feldspar Porphyry (Salmon R. suite)
Monzodiorite (Miller's Brook Suite)
ORDOVICIAN
Kelvin Glen Group
LATE HADRYNIAN-EARLY CAMB
Granodiorite (Chisolm Brook Suite)
Monzogranite (Irish Cove Suite)
HADRYNIAN
Stirling Belt
Fourchu Group
○ Galena in sandstone
□ Galena in carbonate
△ Galena in celestite
▲ Stratiform celestite
◇ Stratiform barite
+ Stratabound Mn, Fe oxides

Figure 2. Geology of the Glengarry Half Graben, Loch Lomond Basin and surrounding area showing the locations of major sulphide and sulphate deposits (modified from Vaillancourt and Sangster, 1986).

upward movement of S-rich basinal fluids and the presence of organic material which acts as a chemical (reducing) trap for ore deposition. The "sed-ex" models involve syn-sedimentary migration of fluids along major structural channel-ways (e.g. faults) and precipitation of ore minerals along contacts between carbonate-evaporite or red bed strata.

Chatterjee (1983) considered the GHG and LLB to represent a single Pb metallogenic domain. The occurrence of numerous Pb±Zn±Fe±Mn mineral deposits and occurrences in strata of the Windsor, Mabou and Cumberland Groups along the margins of the two basins attests to the potential for the discovery of additional deposits within this Pb domain (Sangster and Vaillancourt, 1990).

### 2.3 Geology of the Yava deposit

The Yava Pb deposit was mined between 1979 and 1981 and has drill-estimated reserves that range from 5.6 million tonnes @ 5.3% Pb to 16.9 million tonnes @ 3.4% Pb (Bonham, 1983). The deposit consists of three ore zones, west, central and east (Fig. 3), with a total strike length of approximately 3000 m and down-dip extension of approximately 600m. Ore zones are restricted to paleovalleys between basement ridges of rhyolite porphyry. The ore zones are restricted to the basal 17 m of the coarse clastic Silver Mine Formation (Fig. 4), where it overlies clastic (mostly shale) and chemical sediments of the McKeigan Lake formation (Bonham, 1983).

The deposit predominantly consists of galena which occurs as partial to complete interstitial pore-fillings between clastic quartz grains or as monomineralic layers where quartz and calcite have been variably replaced (Sangster and Vaillancourt, 1990). Minor amounts of other sulphides include pyrite, sphalerite and rare chalcopyrite and pyrrhotite. Minor barite has also been reported (Sangster and Vaillancourt, 1990). Detrital heavy mineral grains may constitute up to 25% of the galena-rich bands and include, in decreasing order, rutile, zircon, ilmenite, magnetite and chromite. The heavy mineral content of average unmineralized Silver Mine Formation rarely exceeds 3%. The ore zones also have elevated amounts of organic material (coalified plant material including tree stems up to 40+ cm in diameter) compared to unmineralized strata. Typically, there is some silicicification of plant debris and extensive kaolinization in the 'grey' sandstone that hosts the Yava Deposit compared to the 'green' sandstone that is typical of the unmineralized, although often pyritic, Silver Mine Formation.

### 2.4 Lithogeochemistry of ore and host rocks

#### 2.4.1 Previous work

In spite of the extensive exploration and production-related activities at the Yava deposit, only minimal lithogeochemical data is available for the ore. Most of this data is in the form of select elemental assays of drill core and, prior to this report, no complete multi-element analyses have been published.

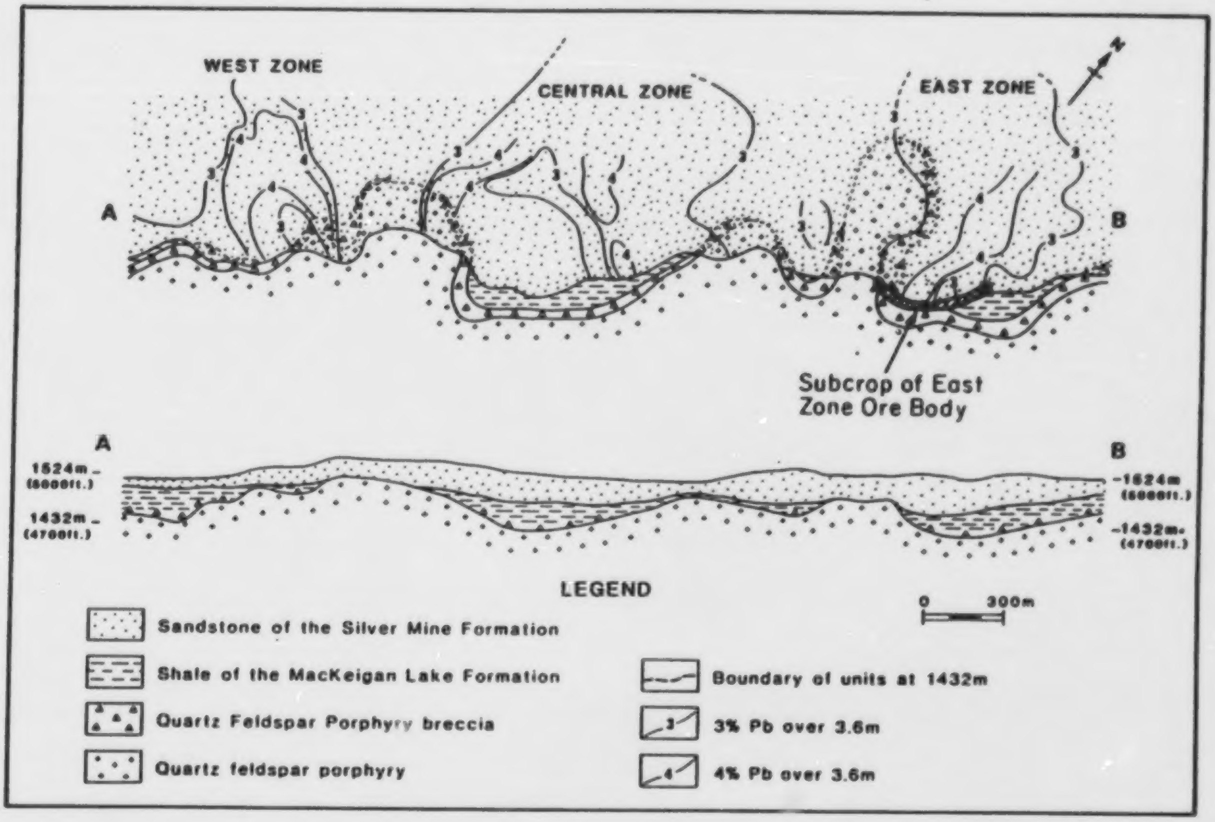

WEST ZONE
CENTRAL ZONE
EAST ZONE
N
A
B
Subcrop of East Zone Ore Body
A
B
1524m (5000ft.)
1432m (4700ft.)
-1524m (5000ft.)
-1432m (4700ft.)
LEGEND
0 300m
Sandstone of the Silver Mine Formation
Shale of the MacKeigan Lake Formation
Quartz Feldspar Porphyry breccia
Quartz feldspar porphyry
Boundary of units at 1432m
3% Pb over 3.6m
4% Pb over 3.6m

Figure 3. Generalized map and longitudinal cross-section of the west, central and east ore zones, Yava deposit. Lead mineralization is restricted to paleovalleys between basement (i.e. rhyolite) ridges). Approximate subcrop of east zone ore body is indicated. (modified from Vaillancourt, 1985).

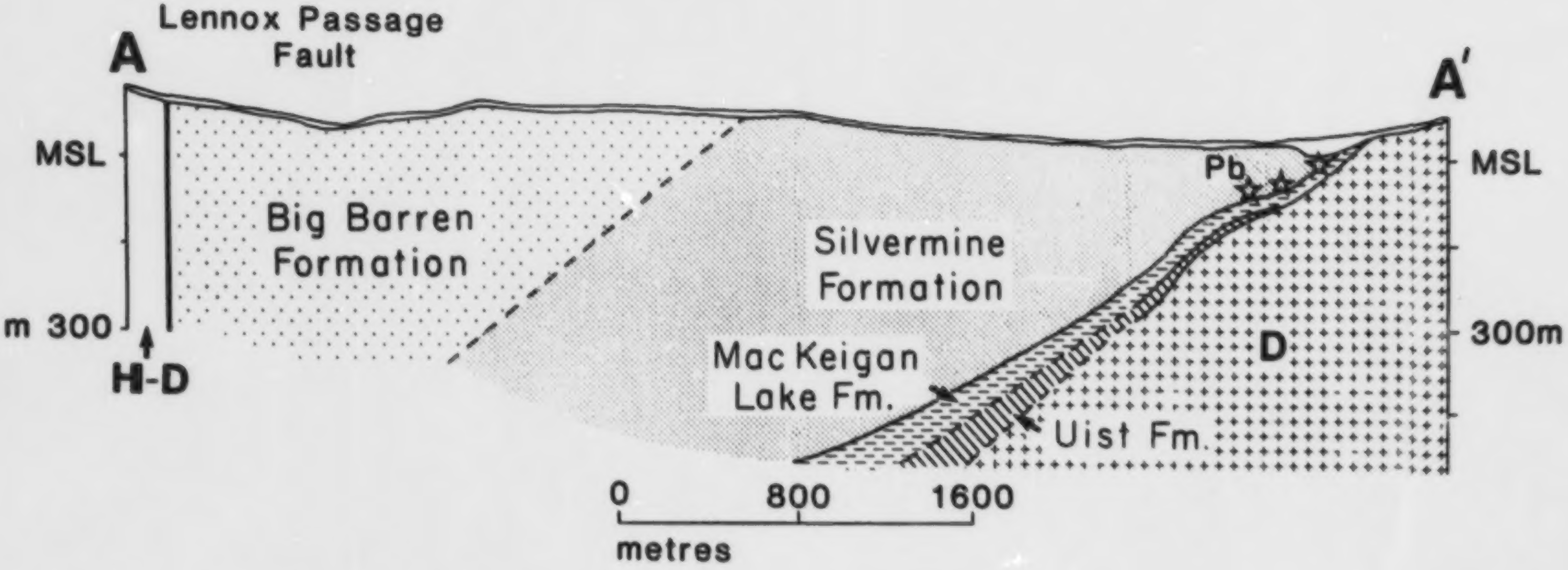

A
Lennox Passage
Fault
A'
MSL
m 300
H-D
Big Barren
Formation
Silvermine
Formation
Mac Keigan
Lake Fm.
Pb
D
Uist Fm.
MSL
300m
0
800
1600
metres

Figure 4. Cross-section, Glengarry Half Graben. Location of section A-A' in figure 2. Stars denote location of galena mineralization (modified from Prime and Boehner, 1984).

Scott (1980) reported values from 100 "galena concentrates" for Sb(17-71, av=40ppm), Ag(13-99, av=36ppm), Cu(10-549, av=52ppm), Zn(370-13,600, av=2800ppm) and Fe(640-115,000, av=11,800ppm). The elevated levels of Fe, Cu and Zn in the concentrates indicates the presence of pyrite, sphalerite and minor chalcopyrite. He also presented Ba and Mn analyses (<0.1-1.7 and <0.1-0.3 wt% respectively) for 62 whole-rock samples collected from outcrops and select diamond drill holes (DDH). Bonham (1983) provides an excellent summary of the development-related work that was used to delineate the ore zones. He reports maximum assay values for Pb that exceed 10%. Patterson (1987) reported assays for Pb, Zn and Ag from mineralized sections of 12 DDHs that were drilled by the Nova Scotia Department of Natural Resources (formerly Mines and Energy) to test possible Zn mineralization and extension(s) of the West Pb Zone. One hole intersected 3.8 ft. of 4.7% Pb, 1.45% Zn and 0.12 oz./tonne Ag. In summary the published lithogeochemical data reflects the predominance of Pb in the Yava deposit, the possibility of significant concentrations of Zn and the subordinate concentrations of Fe, Mn, Sb, Ag, Cu and Ba in the Yava deposit.

### 2.4.2 Specimen collection and analytical procedures

Prior to quantitative analysis of the specimen suite a complete qualitative investigation of five ore samples (mostly 3-5% Pb) using the emission spectrographic facility at the Minerals Engineering Centre of the Technical University of Nova Scotia (TUNS) was conducted. The purpose of this analysis was to determine the approximate levels of a large suite of elements in the Yava ore zone to act as a guide for the interpretation of the ensuing surficial geochemical analyses. The results of this preliminary study are given in Table 1.

The concentrations of Pb($\geq$1%) and Zn($\leq$1%) reflect the presence of galena and sphalerite. The high concentration of Fe (>1%) presumably reflects the presence of pyrite (±marcasite±pyrrhotite), whereas the high Si, Al, Ca and Mg (>1%) mirrors the major mineralogy of the sandstone (i.e. quartz, clay minerals and calcite). The elevated Ba (10 ppm->1%) supports the analyses of Scott (1980) and confirms the presence of barite in the ore, as previously reported by Bjorlykke and Sangster (1981). The comparatively low values of Cu (<100 ppm) and Ag (<10 ppm) corroborate the minor abundance of chalcopyrite and the low concentration of Ag in the galena as noted by Sangster and Vaillancourt (1990). Significant values for Sr (10-1000 ppm) suggest the presence of celestite, which is unreported for the deposit. Conversely, elevated Sr values may indicate the presence of a Sr-bearing carbonate (Boehner pers. comm., 1991). Low to moderate values of Zr, Ti, Ni and Cr probably indicate the presence of rutile, zircon, ilmenite, chromite and possibly Ni-bearing sulphide. However, none of the values reflect heavy mineral concentrations approaching 25% as reported by Sangster and Vaillancourt (1990). Detectable values of B, Be, Co, Sn and Y imply the presence of minor to trace amounts of mineral phases containing these elements. These may include tourmaline, beryl, cassiterite and possibly xenotime and cobaltite, although other mineral species are also possible. The high concentrations of Mn presumably reflects the high levels of Mn in carbonate (D. F. Sangster, pers. comm. 1991).

| Sample | <.0001 % | .0001-.001% | .001-.01% | .01-.1% | 0.1-1 % | +1 % |
|---|---|---|---|---|---|---|
| YBR-90-5 | In,Bi | Be,Y, Sc, Ga<br>Mo, Sn, Ge<br>Ag,Cd | V,Cu,Ni,Co<br>Cr,Sr,B | Zr,Mn<br>Ba,Zn | Ti,Mg<br>Ca | Si,Al,Pb<br>Fe |
| YBR-90-6 | In,Bi | Be,Y,Sc,Ga<br>Mo,Sn,Ge<br>Ag,Cd | V,Cu,Ni,Co<br>Cr,Sr,B | Zr,Mn<br>Zn | Ti,Mg<br>Ca,Ba | Si,Al,Pb<br>Fe |
| YBR-90-7 | In,Bi | Be,Y,Sc,Ga<br>Mo,Sn,Ge<br>Ag | V,Cu,Ni,Co<br>Cr,Sr,B,Ba | Zr,Zn | Ti,Mn | Si,Al,Pb<br>Fe,Mg,Ca |
| YBR-90-8 | In,Bi | Be,Y,Sc,Ga<br>Mo,Sn,Ge<br>Ag | V,Cu,Ni,Co<br>Cr,Sr,B | Zr,Mn<br>Zn | Ti,Ca | Si,Al,Pb<br>Fe,Mg,Ba |
| YBR-90-9 | In,Bi | Be,Y,Sc,Ga<br>Mo,Sn,Ge<br>Ag,Cd | V,Cu,Ni,Co<br>Cr,B | Zr,Mn<br>Sr | Ti,Mg<br>Ca,Zn | Si,Al,Pb<br>Fe,Ba |

**No analysis for K and Li,** used in buffer. If not listed, not detected, but if present:
**<1% = Na,P; <.1% = Ta;** <.05% = U; <.033% = Th,Ce; <.01% = As, W, Nd, Nb; <.005% = La; **<.001% = Hg, Sb, Yb, Te; <.0001% = Tl,Cd**

**Table 1. Analytical data from Emmission** Spectographic Scans for samples of ore from the West **Zone of the Yava deposit.**

Following the spectrometric analysis a suite of 27 samples were submitted for assay and trace element analysis for Pb, Zn and Cu. The purpose of this is to establish the lithogeochemical signature within the ore zone and quantify the amount of enrichment, specifically in Pb, Zn and Cu, in the ore zone versus the unmineralized Silver Mine Formation and adjoining rhyolite basement rocks. Trace element analysis and assays were conducted using Aqua Regia/perchloric-hydrofluoric "total" acid digestion and atomic absorption spectrometry (AAS) at the Minerals Engineering Centre at TUNS. The sample suite included 8 specimens of conglomerate and massive and coal-bearing sandstone from the ore pile at the west zone (YBR-90-6 to -90-13). In addition, 14 specimens of unmineralized and ore-horizon Silver Mine Formation (YD164-100.6 to -712.0) were sampled at approximately 50 foot intervals from diamond drill hole #164 (Boehner and Prime, 1985) located at approximately 650 N 250 E of our sample grid (Fig. 12). Two massive, reddish-brown coloured rhyolite porphyry specimens were collected from a large outcrop located approximately 200-300 m south of the west zone decline (YBR-90-1 and -90-4; Table 2). Two samples of rhyolite with minor to abundant fracture-related alteration (hematization, kaolinization) were also collected from this same outcrop (YBR-90-2 and -90-3 respectively). Analytical results and brief sample descriptions for all 27 samples are given in Table 2.

Several conclusions can be drawn from the data in Table 2. The massive rhyolite (YBR-90-1) has Pb and Zn values (44 and 38 ppm respectively) that approximate to published values for the Salmon River Porphyry (av=30 and 31 ppm respectively; Barr et al., 1984). However, other rhyolite samples (YBR-90-2,3,4) are enriched in both Pb and Zn. The highest values were noted in the most altered samples (1940 ppm Pb and 288 ppm Zn in YBR-90-3). The other two rhyolite samples also show slight amounts of similar alteration. The lead enrichment in these samples may genetically related to reported galena occurrences within the rhyolite porphyry near Silver Mine.

Unmineralized Silver Mine Formation sediments from DDH #164 (i.e. YD164-100.6 to -555.0) generally have low concentrations of Pb (mostly <60 ppm), Zn (mostly <100ppm) and Cu (<30 ppm). Minor enrichment in Pb were noted in YD164-350.0 (235 ppm) and YD164-555.0 (450 ppm) and YD164-200.0 contains 1000 ppm Zn. Ore grade and elevated values of Pb and Zn reaching 8.94% Pb and 0.60% Zn were noted in YBR-90-6 to -90-13 and YD164-615 to -694.

The significant contrast between the Pb and Zn concentrations of the Yava ore zone and those of both unmineralized Silver Mine Formation and Salmon River Porphyry are readily detectable by several exploration geochemical techniques. The enrichment in Pb in alteration zones in the porphyry may, if large enough, complicate the interpretation of surficial geochemical anomalies associated with the sandstone-hosted Yava ore zones.

| | | PPM | | | | |
|---|---|---|---|---|---|---|
| Sample Number | | Pb | Zn | Cu | Description | |
| YBR - 90 - | 1 | 44 | 38 | 2 | Massive rhyolite | rhyolite porphory |
| YBR - 90 - | 2 | 1080 | 130 | 5 | Rhyolite with rusty zones | |
| YBR - 90 - | 3 | 1940 | 288 | 11 | Rhyolite abundant rusty zones | |
| YBR - 90 - | 4 | 288 | 63 | 5 | Massive rhyolite | |
| YBR - 90 - | 5 | 29600 | 452 | 6 | Massive grey sandstone outcrop at decline | |
| YBR - 90 - | 6 | 85900 | 750 | 13 | Grey sandstone with galena bands | from ore dump |
| YBR - 90 - | 7 | 66000 | 580 | 10 | Grey sandstone with galena bands | |
| YBR - 90 - | 8 | 48300 | 577 | 5 | Grey sandstone with galena bands | |
| YBR - 90 - | 9 | 89400 | 2560 | 37 | Sandstone with abundant coal fragments | |
| YBR - 90 - | 10 | 548 | 132 | 8 | Massive grey sandstone - weathers brown | |
| YBR - 90 - | 11 | 47000 | 6000 | 23 | Limestone conglomerate | |
| YBR - 90 - | 12 | 18600 | 270 | 21 | Limestone conglomerate | |
| YBR - 90 - | 13 | 2390 | 135 | 16 | Limestone conglomerate | |
| YD 164 - | 100.6 | 14 | 64 | 29 | Massive to finely laminated grey sandstone with common pyrite - bearing zones. | diamond drill hole #164 |
| YD 164 - | 150.0 | 13 | 78 | 4 | | |
| YD 164 - | 200.0 | 56 | 1000 | 12 | | |
| YD 164 - | 250.0 | 11 | 83 | 6 | | |
| YD 164 - | 300.0 | 19 | 84 | 5 | | |
| YD 164 - | 350.0 | 235 | 65 | 5 | | |
| YD 164 - | 400.0 | 42 | 55 | 8 | | |
| YD 164 - | 450.0 | 9 | 72 | 7 | | |
| YD 164 - | 500.0 | 28 | 107 | 6 | | |
| YD 164 - | 555.0 | 450 | 197 | 8 | | |
| YD 164 - | 615.0 | 98 | 1460 | 12 | | |
| YD 164 - | 655.0 | 1670 | 3350 | 11 | Medium grained sandstone with coarse layers | |
| YD 164 - | 694.0 | 28800 | 971 | 28 | Sandstone and conglomerate | |
| YD 164 - | 712.0 | 75 | 156 | 9 | Conglomerate | |

Table 2. Pb, Zn, Cu assays for mineralized and barren Silvermin Formation, limestone conglomerate of the McKeigan Lake Formation and rhyolite porphry of the Loch Lomond Plutonic Complex.

## 3 PREVIOUS GEOCHEMICAL EXPLORATION STUDIES

The most extensive exploration geochemical program covering the Yava deposit area was conducted by Talisman Mines Ltd. and Phelps Dodge Corp. of Canada Ltd. in 1961-62. The results of this study are given in Geisler (1963). Approximately 1630 "soil samples" were collected at 100 ft. intervals along cut lines spaced 300-400 ft. apart. Samples were collected with augers from a depth of 2.5 ft.. Samples were dried and a -80 mesh (-177 μm) fraction was sieved and analysed for Pb, Zn and Cu using colorimetric techniques with the organic reagent dithizone and toluene solvent.

Geisler (1963) reports Pb values in soils ranging from below detection limit to >10 000 ppm. Several elongate northeast-trending Pb anomalies were defined within a 4 km x $\leq$750 m zone and are displayed in Figs. 5a and 5b. Zinc values ranging from 0 to 2000 ppm also defined a series of anomalies that mirrored those for Pb. Copper contents were mostly very low (0-20 ppm), however, two anomalous areas with $\leq$1300 and $\leq$250 ppm were defined. The highest Pb, Zn and even Cu anomalies were located along "catchment basins" or in topographically low areas. Geisler (1963) concluded the anomalies represented "hydromorphic derivatives of Pb and Zn mineralization that is associated with the Windsor/Pennsylvanian contact". The anomalies were considered to be "displaced by topography", that is, metals were thought to be dissolved and transported in groundwater and precipitated in low-lying, swampy areas where reducing conditions prevailed.

Following the discovery of the Yava deposit, and prior to commencement of development-related activities, a series of orientation studies were initiated by the Geological Survey of Canada to determine the applicability of biogeochemical prospecting (Carter, 1965; Fortescue and Hornbrook, 1969). The most extensive study was conducted by E.H.W. Hornbrook during the summer of 1966 and reported in Fortescue and Hornbrook (1969). Specimens were collected from 45 stations at 100 ft. intervals along the main N-S baseline of Talisman Mines Co. Ltd. which extended from the rhyolite porphyry northward across the central zone ore body and then over unmineralized Silver Mine Formation sediments. A total of 494 multi-media specimens were collected including: lower, middle and upper level bark and first, second and third year growth (twigs and needles) from Balsam Fir or black spruce; "A" horizon humus; "B" and "C" horizon "soil" horizons. They evaluated and compared the relative sensitivities of spectrographic and colourimetric analytical techniques. They concluded that biogeochemical prospecting techniques could successfully be used to delineate the Yava deposit (Fig. 6). Similarly both soils and humus surveys yielded similar results and adequately delineated the Pb deposit. A strong anomaly/background contrast for Ba, that far exceeded that of Pb, prompted Fortescue and Hornbrook (1969) to recommend the use of Ba as a biogeochemical pathfinder element for Yava-type deposits.

The entire GHG, LLB and adjoining areas were covered by a stream sediment survey that was initiated by the Nova Scotia Department of Mines and Energy during the 1982 field season (Rogers, 1983). Wherever possible, samples were collected at approximately 2 km intervals along most first, second and third order streams. Sample preparation and analytical

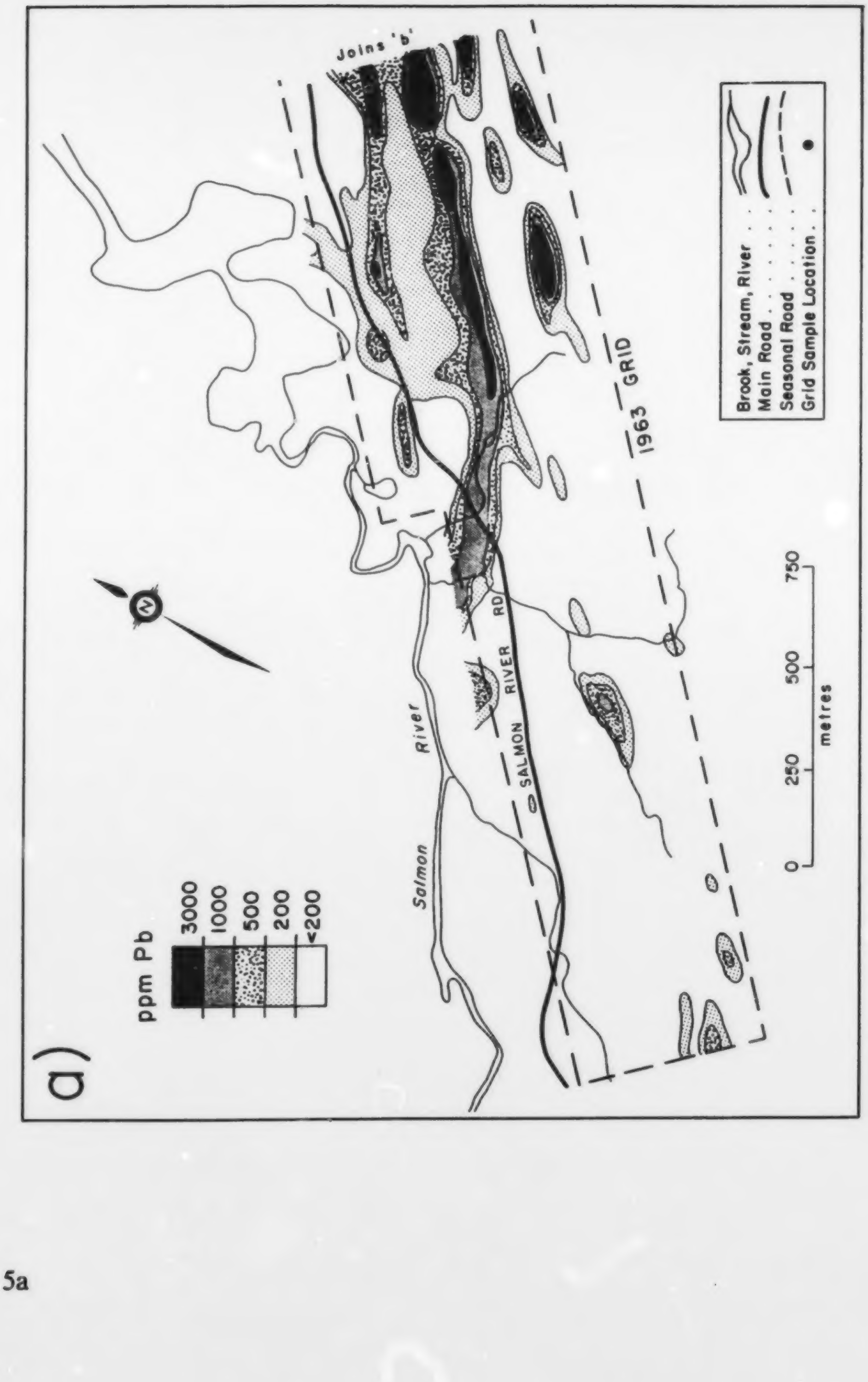

a)
ppm Pb
3000
1000
500
200
<200
Salmon
River
SALMON
RIVER
RD
Joins 'b'
1963 GRID
N
0
250
500
750
metres
Brook, Stream, River . .
Main Road . . . . . . .
Seasonal Road . . . . . .
Grid Sample Location . .

Figure 5a

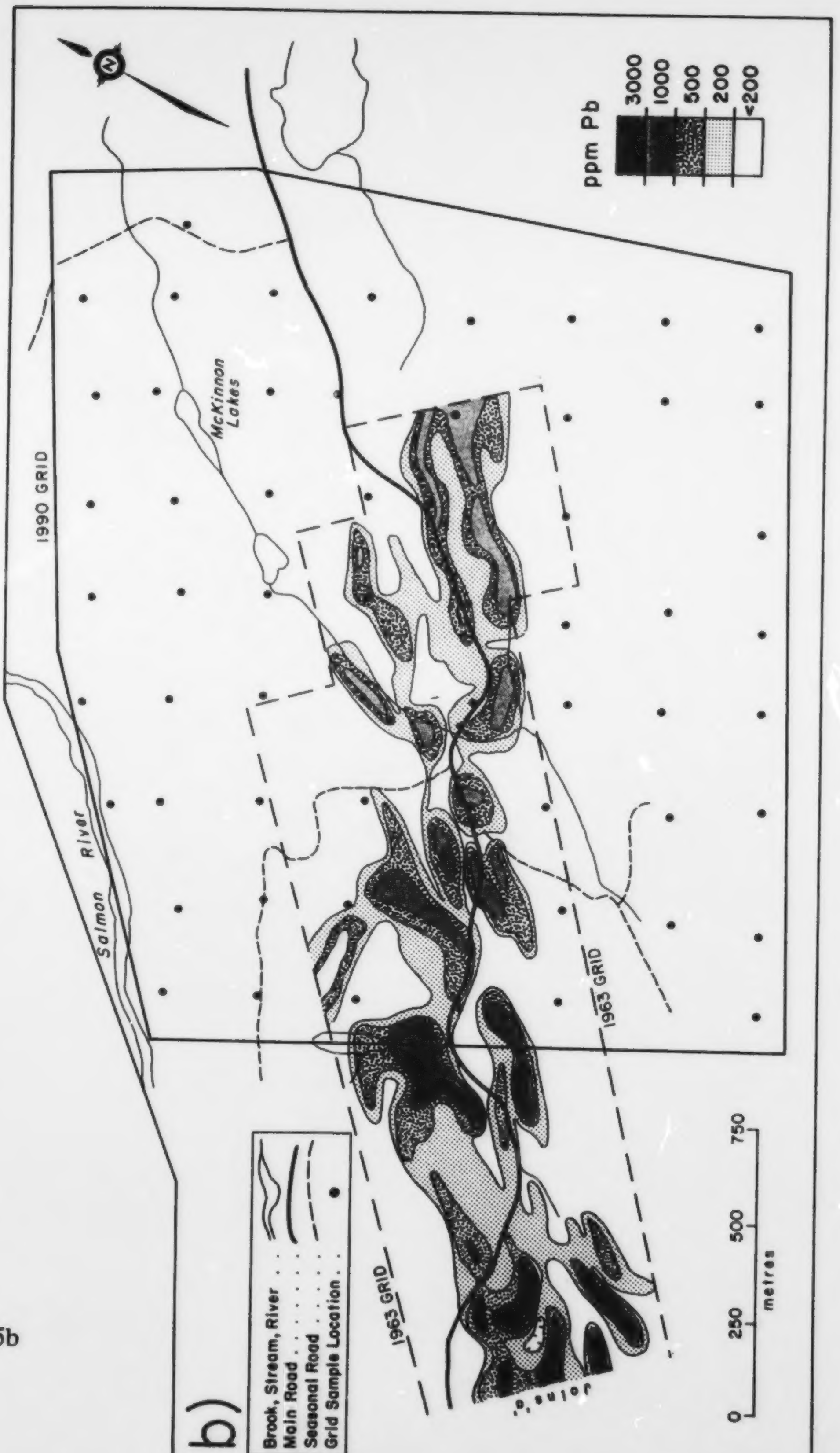

b)
N
ppm Pb
3000
1000
500
200
<200
1990 GRID
McKinnon Lakes
Salmon River
1963 GRID
1963 GRID
Brook, Stream, River
Main Road
Seasonal Road
Grid Sample Location
0
250
500
750
metres

Figure 5b

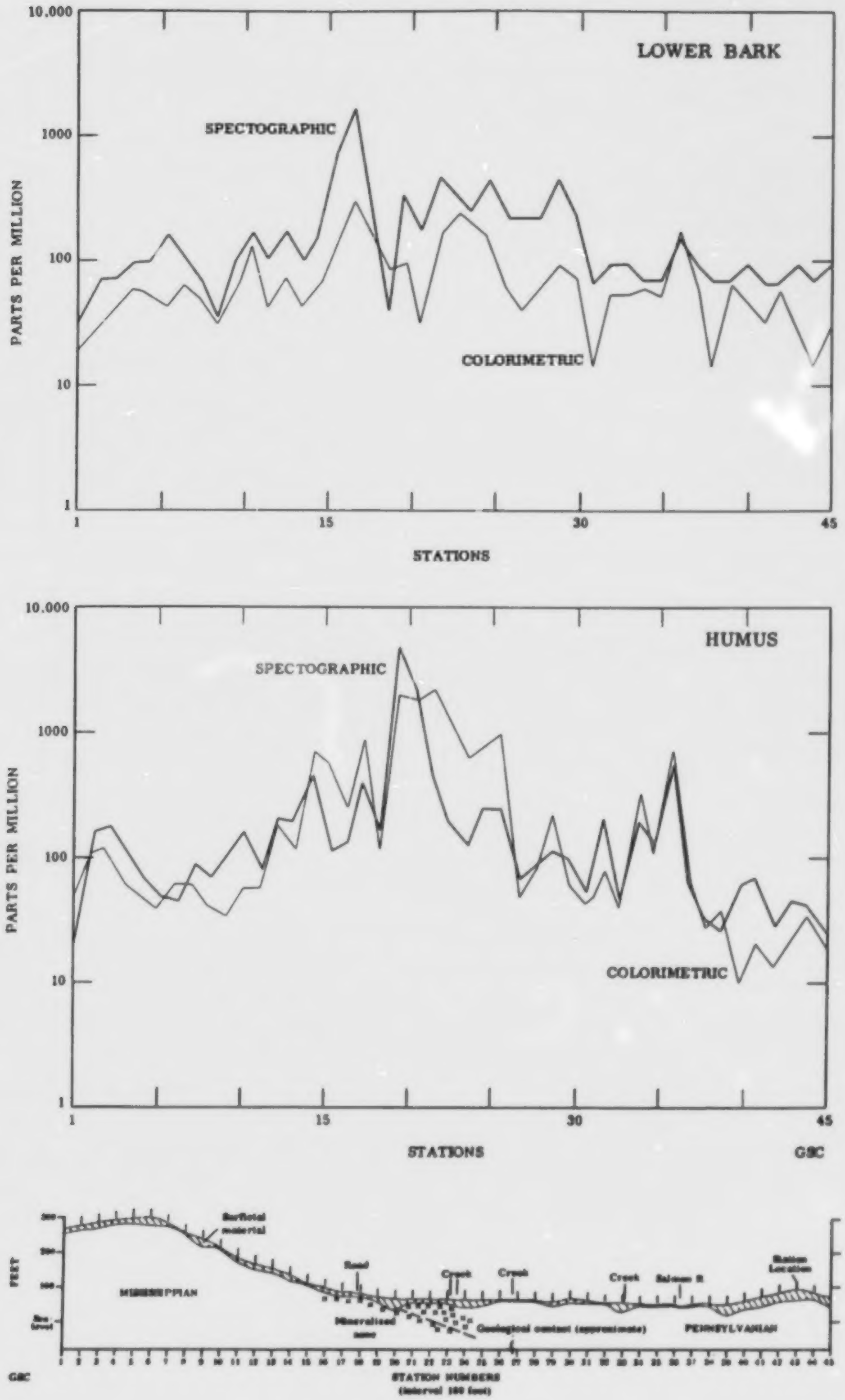


Figure 6. Analytical results and geologic cross-section across the main zone, Yava deposit. Data from a geochemical pilot study conducted by the Geological Survey of Canada (modified from Fortescue and Hornbrook, 1969).

techniques are given in Rogers (1983). In 1983 the study area was covered by a lake sediment survey that collected 350 centre lake bottom gyttja samples from eastern Cape Breton lowlands (Rogers and MacDonald, 1984b). Combined analytical results from both surveys were plotted on a series of 1:50 000 scale single element Open File Maps (Rogers and MacDonald, 1986). Basic statistics (mean, Std. Dev., range) were calculated using the combined results of both surveys. Initial inspection of the data indicates that there are, as would be expected, substantial variations in the geochemical response between stream sediments and lakes. Most streams and lakes that overlie the margin of the GHG between Big Glen and Rock Elm (Fig. 2) are enriched in Pb (>100 ppm) when compared to the central portions of the GHG where values of 10-40 ppm predominate. In fact 7 streams and 4 lakes contain 335-1450 and 270-3300 ppm Pb respectively. Similarly most streams are enriched in Zn with values of 100-300 compared to central parts of the GHG (<100ppm). Three lake sediments near the Yava deposit yielded very high values of Zn (3500, 5300 and 7500 ppm). Most stream sediment samples from the area have high Zn (100-300 ppm) compared to the centre of the GHG. There is a general absence of Cu enrichment that confirms the absence of Cu enrichment in the previous survey (Geisler, 1963). Only one stream sample contained elevated Ag (0.3 ppm) whereas the majority of the basin displayed values of 0.1-0.2 ppm Ag. In contrast several lakes in the Yava area contained 0.3-0.7 ppm Ag, however, the low Ag values are consistent with the Ag content of the Yava ore bodies as discussed earlier. In short, many stream and lake sediments from the eastern perimeter of the GHG near the Yava Mine contain elevated values of Pb and Zn.

Lombard (1991) presents plots showing the distribution of trace elements from the 1982, 83 stream sediment surveys. The data has been plotted using percentile intervals (e.g. 80th, 90th and 95th) derived from the entire data set. The plots of Pb, Zn, Cu and Ag for eastern Cape Breton Island have been enlarged and are presented in Figs 7a to d. A geological overlay showing the location of the GHG and LLB is located in the pocket at the back of this report. Several observations can be made from the data of Lombard (1991). Firstly, a large area with elevated Pb and Zn (≥95th percentile) that extends from the eastern margin of the GHG to the LLB and southeast into the "Stirling belt" containing massive sulphide mineral deposits. In contrast the stream sediments from this same area have Cu and Ag values below the 60th percentile of the entire data set. The streams from the "Stirling Belt" have high levels of both Cu and Ag (≥95th percentile).

In 1987 the study area was resampled as part of a Nova Scotia Department of Mines and Energy stream silt, heavy mineral and water survey that encompassed all of northern Nova Scotia and Cape Breton Island. Details regarding sample collection and preparation and analytical techniques along with tables of analytical data are given in Mills (1989). Analysis of the -230 mesh (-62.5$\mu$m) fraction of stream sediments was done by Directly Coupled Plasma-Atomic Emission Spectroscopy (DCP-AES). Pb was not included in this analytical package, although Cu and Zn were. Two samples in the vicinity of the Yava deposit have values of Zn (615, 625 ppm) and Cd (3.0, 6.2 ppm) that are elevated compared to samples from the remainder of the GHG and LLB. Analysis of heavy mineral separates from the -60+230 mesh (-250+62.5 $\mu$m) fraction of the stream sediments was done by Instrumental

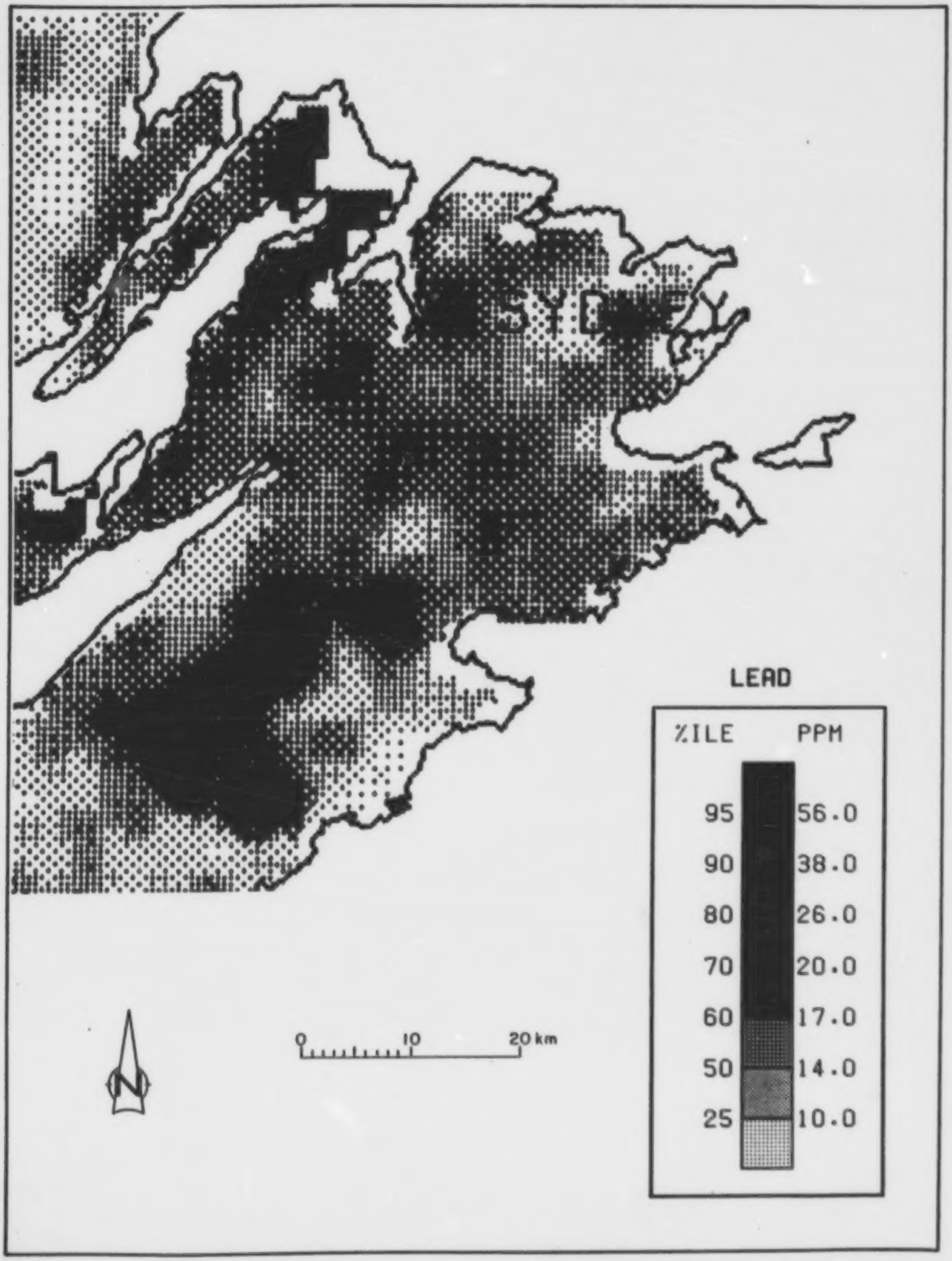

SYDNEY
LEAD
%ILE
PPM
95
56.0
90
38.0
80
26.0
70
20.0
60
17.0
50
14.0
25
10.0
0
10
20 km
N

Figure 7a

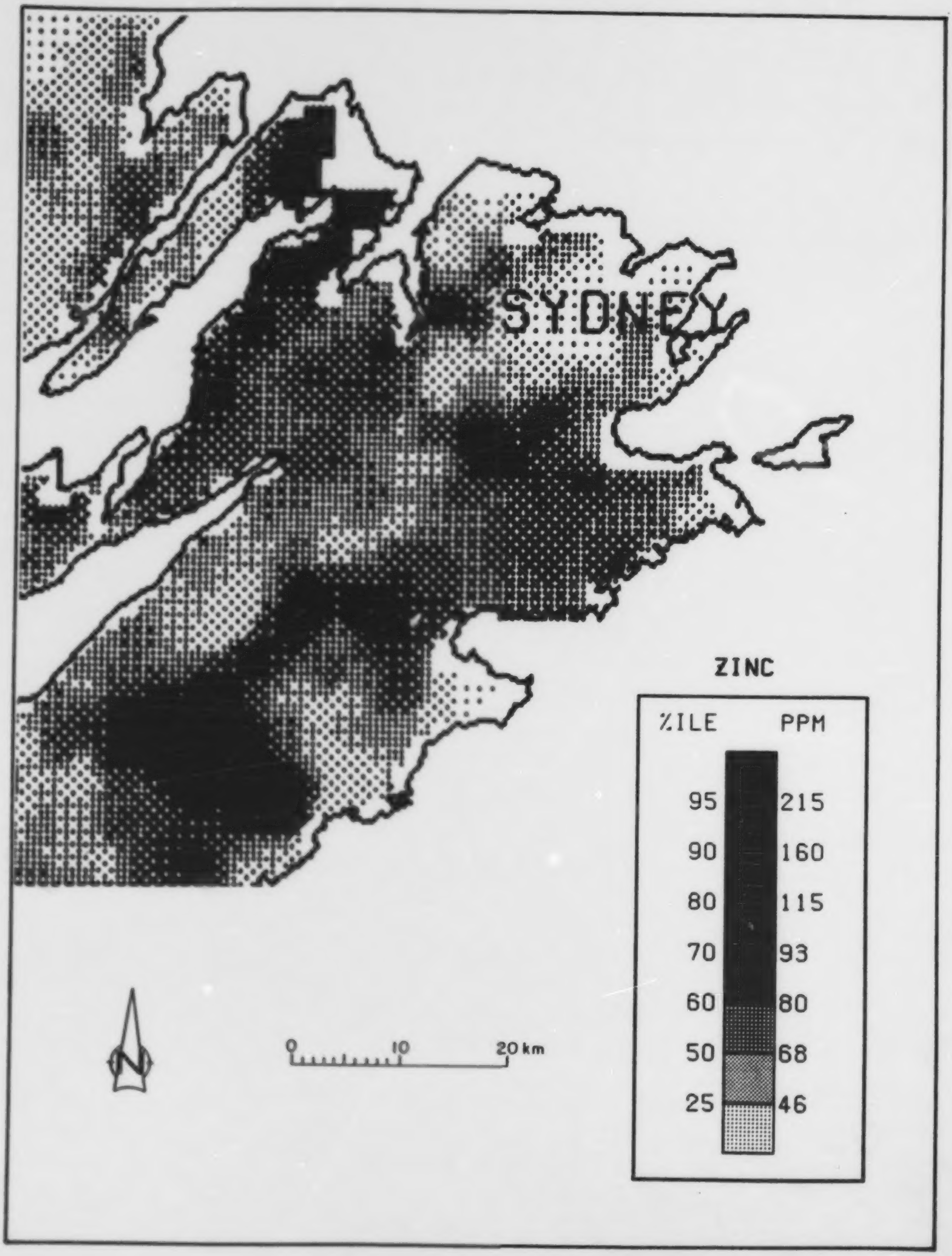

SYDNEY
ZINC
%ILE
PPM
95
215
90
160
80
115
70
93
60
80
50
68
25
46
N
0
10
20 km

Figure 7b

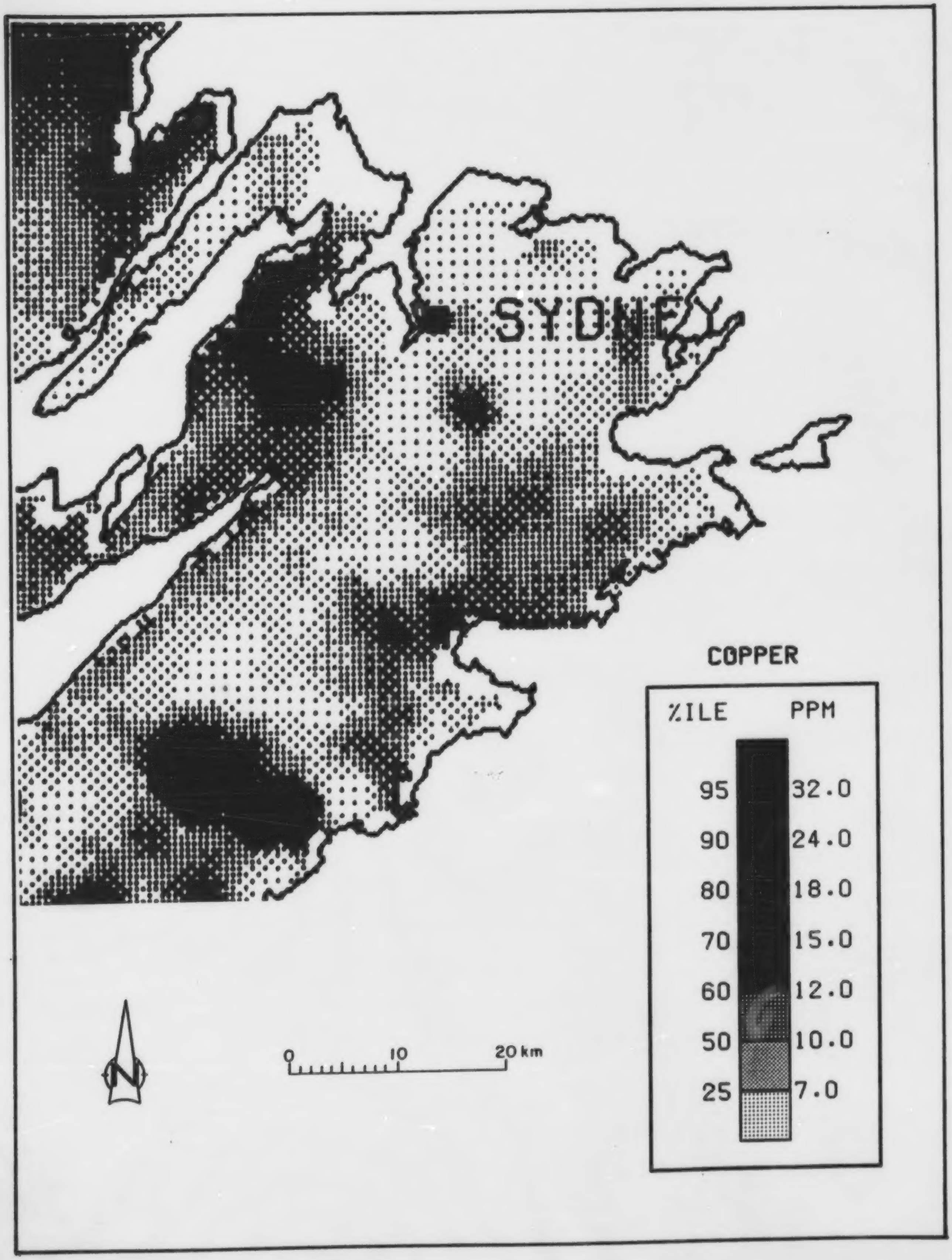

SYDNEY
COPPER
%ILE
PPM
95
32.0
90
24.0
80
18.0
70
15.0
60
12.0
50
10.0
25
7.0
N
0
10
20 km

Figure 7c

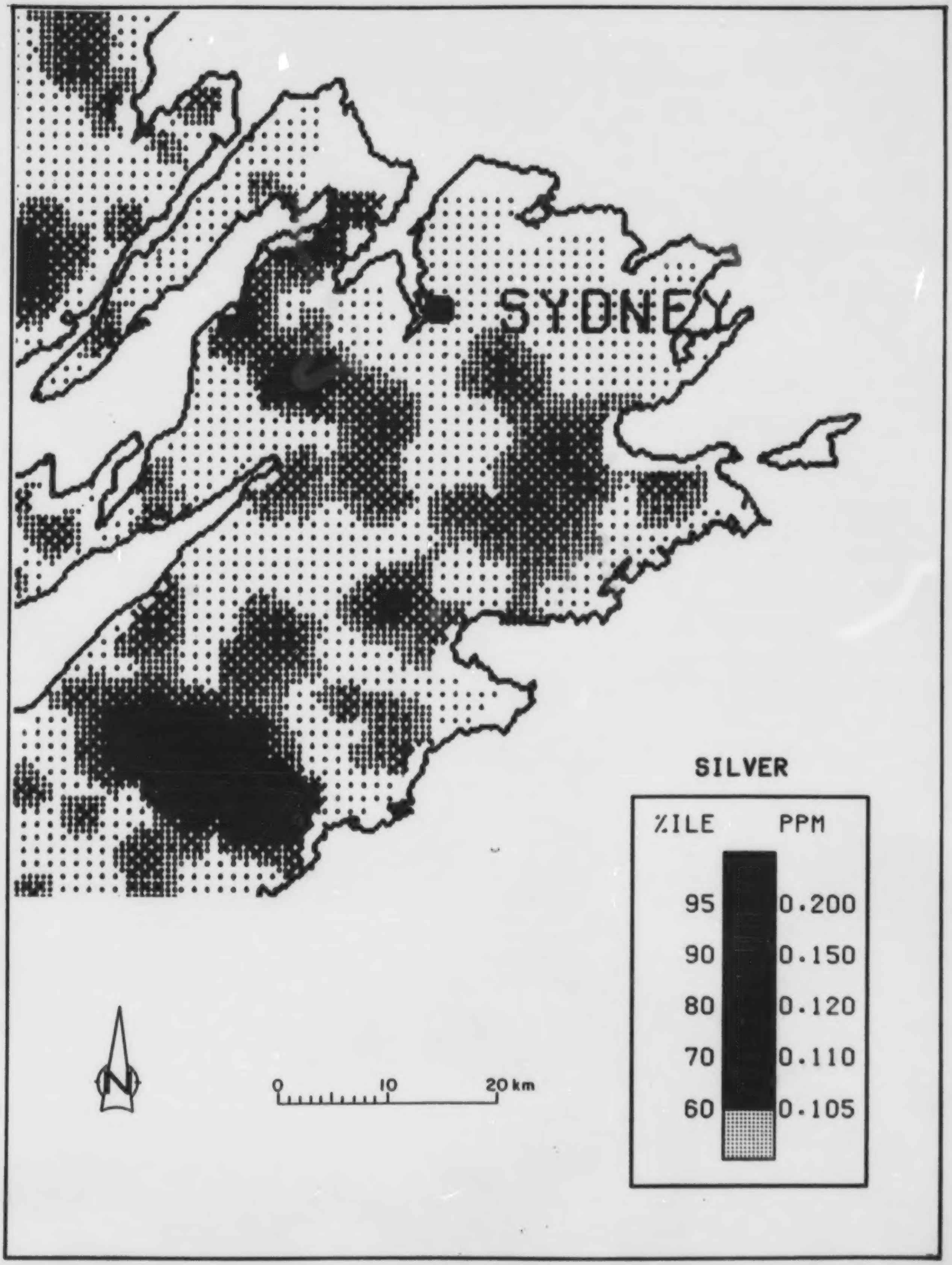

SYDNEY
SILVER
%ILE
PPM
95
0.200
90
0.150
80
0.120
70
0.110
60
0.105
N
0
10
20 km

Figure 7d

Neutron Activation Analysis (INAA). Both Pb and Cu have high detection limits and poor accuracy by this technique and were not included in the analytical package. Analysis of heavy mineral separates from the -60+230 mesh (-250+62.5 μm) fraction revealed 3 samples with elevated Zn (1600, 3000 and 7100 ppm) near the Yava deposit. Also 3 samples contained elevated Ba (3400, 3500 and 11 000 ppm).

In summary, it has been established that the Yava deposit, and indeed much of the eastern margin of the GHG, has a pronounced geochemical signature for Pb and Zn. Anomalies can readily be detected in many surficial sampling media including stream silts/clays and heavy minerals, glacial tills, humus and "B" horizon soils and several organs from both Balsam Fir and black spruce trees.

## 4 SURFICIAL GEOLOGY

The area surrounding the Yava deposit is typified by a hilly drumlinized landscape. The low areas between drumlins often contain organic deposits. With the exception of minor post-glacial and modern fluvial deposits along the Salmon River, the entire study area is blanketed by a sandy ground moraine (unit 2b) that averages 2 to 4 m in thickness (Grant, 1988; Fig. 8). The northeastern part of the study area is underlain by a reddish brown silty and clayey, moderately compacted till (unit 2a) that averages 10 m in thickness and is generally blanketed by unit 2b. Grant (1988) noted that unit 2a may occur as drumlin fields as seen in the southeastern part of figure 7, as large transverse ridges or as rolling fluted plains.

There are very few outcrops in the study area and no reported glacial striations which makes inferences about ice directions problematic. However, Grant (1988) has recorded numerous striae throughout Cape Breton Island and proposes a sequence of 5 major ice movements (Fig. 9). All of the drumlins in the study area are oriented to the northeast suggesting that they were deposited by Grant's (1988) northeast ice flow phase #3. It is not clear whether both units 2a and 2b were deposited by the same ice movement, however, the main direction for glacial dispersion is presumably to the northeast.

In contrast, Fortescue and Hornbrook (1969) proposed a complex glacial history for the area that included two periods of ice advance in opposite directions. Both proposed ice flows were oriented parallel to the long axis of the drumlins. It was not indicated which ice flow directions were attributed to the upper and lower till sheets (units 2b and 2a respectively).

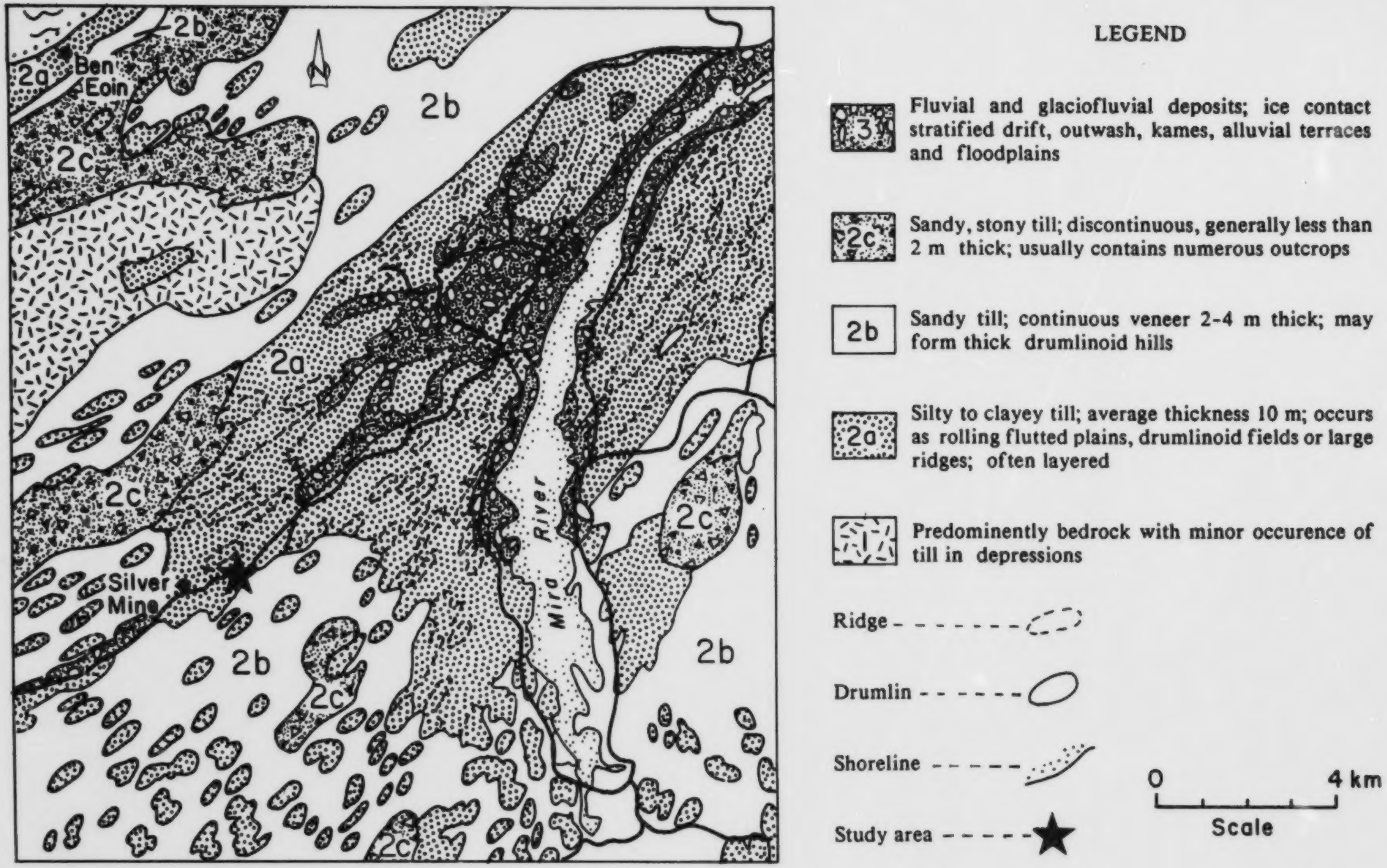

2a
Ben Eoin
2b
2c
1
2b
2a
2c
Silver Mine
2b
2c
River Mira
2c
2b
2c
LEGEND
3 Fluvial and glaciofluvial deposits; ice contact stratified drift, outwash, kames, alluvial terraces and floodplains
2c Sandy, stony till; discontinuous, generally less than 2 m thick; usually contains numerous outcrops
2b Sandy till; continuous veneer 2-4 m thick; may form thick drumlinoid hills
2a Silty to clayey till; average thickness 10 m; occurs as rolling flutted plains, drumlinoid fields or large ridges; often layered
1 Predominently bedrock with minor occurence of till in depressions
Ridge
Drumlin
Shoreline
Study area
0
4 km
Scale

Figure 8. Generalized glacial geology of the study area (modified from Grant, 1988).

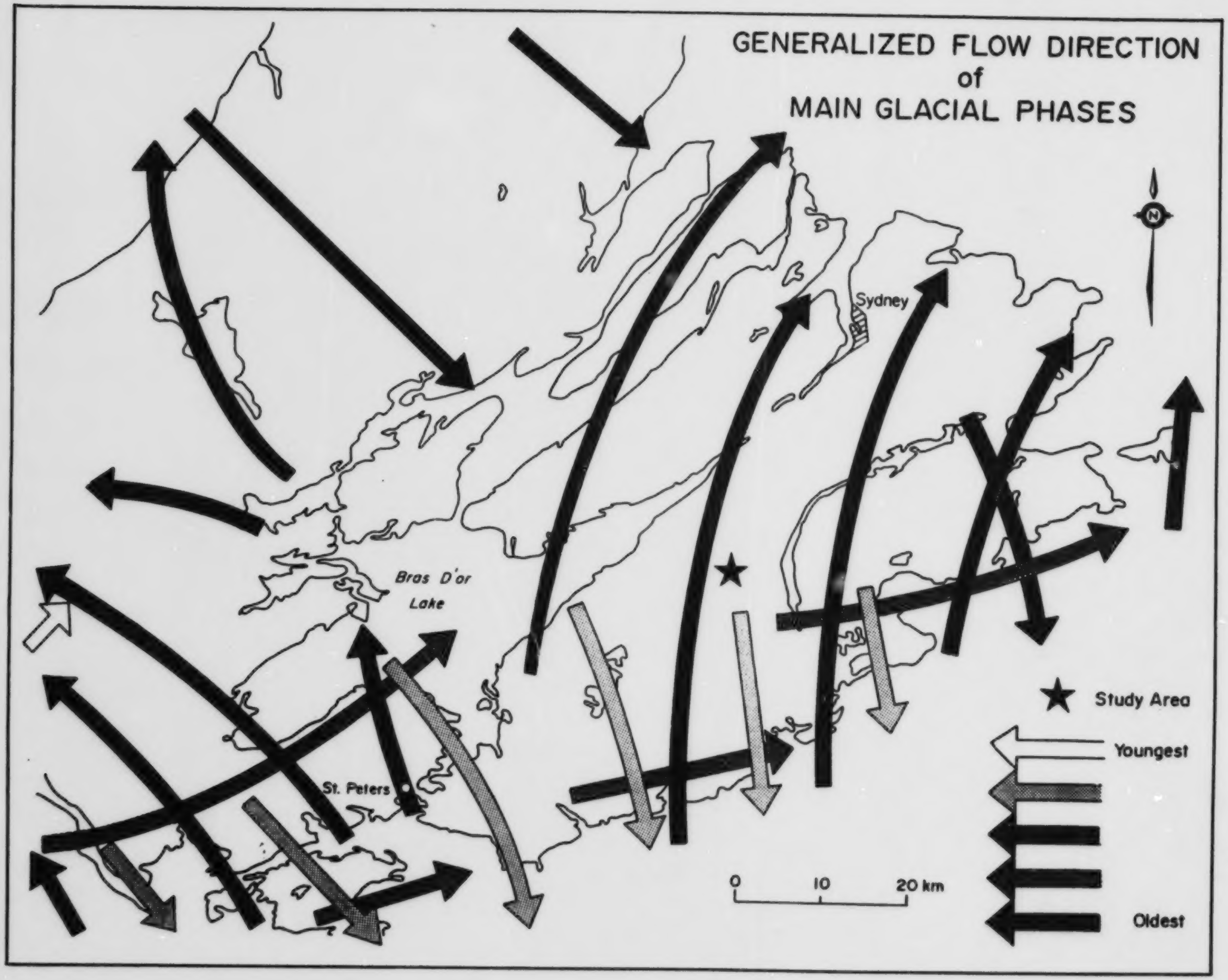

GENERALIZED FLOW DIRECTION
of
MAIN GLACIAL PHASES
N
Sydney
Bras D'or
Lake
St. Peters
Study Area
Youngest
Oldest
0
10
20 km

Figure 9. Proposed sequence of major ice movements in eastern Cape Breton Island (modified from Grant, 1988).

# 5 OVERBURDEN DRILLING

## 5.1 Purpose

Prior to the grid and stream sampling an overburden drilling programme was conducted. The purpose of the drilling was to obtain information pertaining to the glacial geology near the east zone orebody and evaluate the proposed stratigraphy of Grant (1988).

## 5.2 Methodology

Initial visits to the study area indicated that much of the sandy ground moraine (unit 2b) along the Salmon River Road contained a high proportion of cobble- to boulder-sized rhyolite or sandstone clasts. The stoney nature of the tills prohibited the use of sonic drilling techniques to core the overburden. Also, projected overburden depths of up to 45 m (M. Grice, pers. comm. 1990) negated the use of a backhoe trenching to reach bedrock. Accordingly, it was decided that conventional diamond drilling equipment from the Nova Scotia Department of Natural Resources (formerly Mines and Energy) Drilling Division would be employed. To maximize core recovery a triple-tube core barrel was used.

A series of nine drill holes were planned. Five of the holes were to be drilled at 250 metre intervals along the Salmon River Road commencing over the subcrop of the east zone ore and extending for 1 km to the east. These holes were to give a cross-section through a large drumlin. In addition, two holes were to be drilled both north and south of the ore subcrop.

## 5.3 Results of Drilling

The first hole (YOB-90-1) was collared above the projected subcrop of the East Zone orebody (Fig. 10). Two separate holes were attempted but both had to be abandoned because of bit failure. In both holes the bit became oversized, from drilling highly competent rhyolite boulders, resulting in boulders jamming in the core barrel. None of the till matrix was recovered in either of the holes, although the core barrel contained numerous till clasts. The paucity of recovered matrix presumably results from the liquefaction of the loose sandy ground moraine by drilling fluids. Plate 1a shows the typical core recovery in YOB-90-1.

A complete log of YOB-90-1 is given in Fig. 11. Clast counts from various segments of the hole indicate that rhyolite is consistently the dominant clast-type (55 to 81%) whereas sandstone ranges from 1 to 32%. Granite clasts from more distal parts of the Loch Lomond Plutonic Complex make up 4.5 to 22% of the total clast population whereas other "foreign" clasts (mostly metasediments and metavolcanics) account for 4.5 to 11%. It is noteworthy that the only section with significant matrix recovery is near the bottom of the hole where the percentage of sandstone is highest (32%). One mineralized sandstone boulder (YOB-90-1-4c) was intersected at approximately 4 m depth. An assay of this boulder (Fig. 11) for Pb, Zn, Cu and Cd returned 30500, 1300, 30 and 9 ppm respectively.

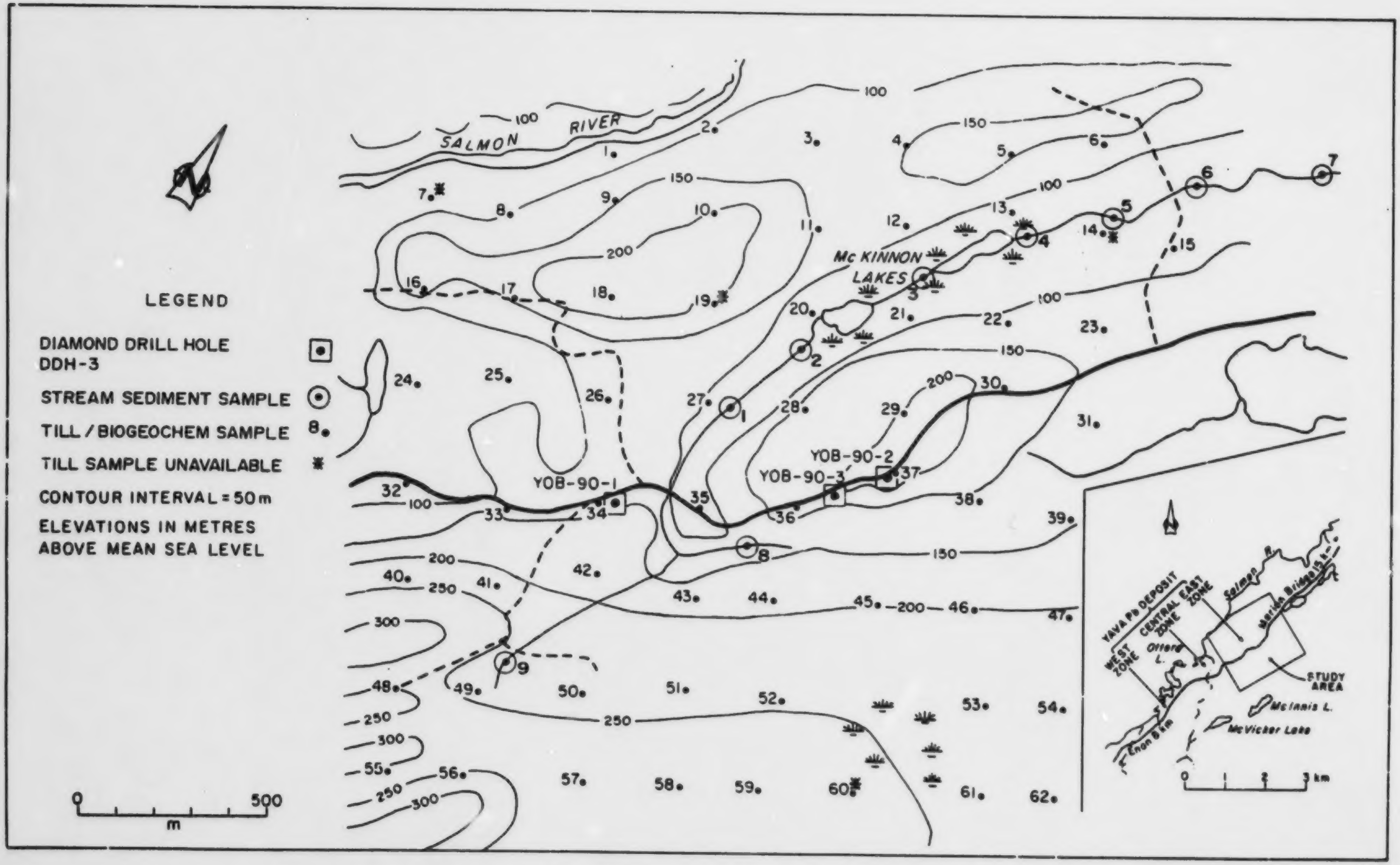

LEGEND
DIAMOND DRILL HOLE DDH-3
STREAM SEDIMENT SAMPLE
TILL / BIOGEOCHEM SAMPLE 8
TILL SAMPLE UNAVAILABLE
CONTOUR INTERVAL = 50 m
ELEVATIONS IN METRES ABOVE MEAN SEA LEVEL
0
500
m
SALMON RIVER
Mc KINNON LAKES
YOB-90-1
YOB-90-2
YOB-90-3
100
150
200
250
300
YAVA Pb DEPOSIT
WEST ZONE
CENTRAL ZONE
EAST ZONE
Offord L.
Salmon R.
Marion Bridge 15 km
Enon 8 km
STUDY AREA
McInnis L.
McVicker Lake
0
1
2
3 km

Figure 10. Location of overburden diamond drill holes, stream sediments and grid sampling stations from this study. Contours are for topography. The presumed ice flow direction is parallel to the long axes of the drumlinoid ridges.

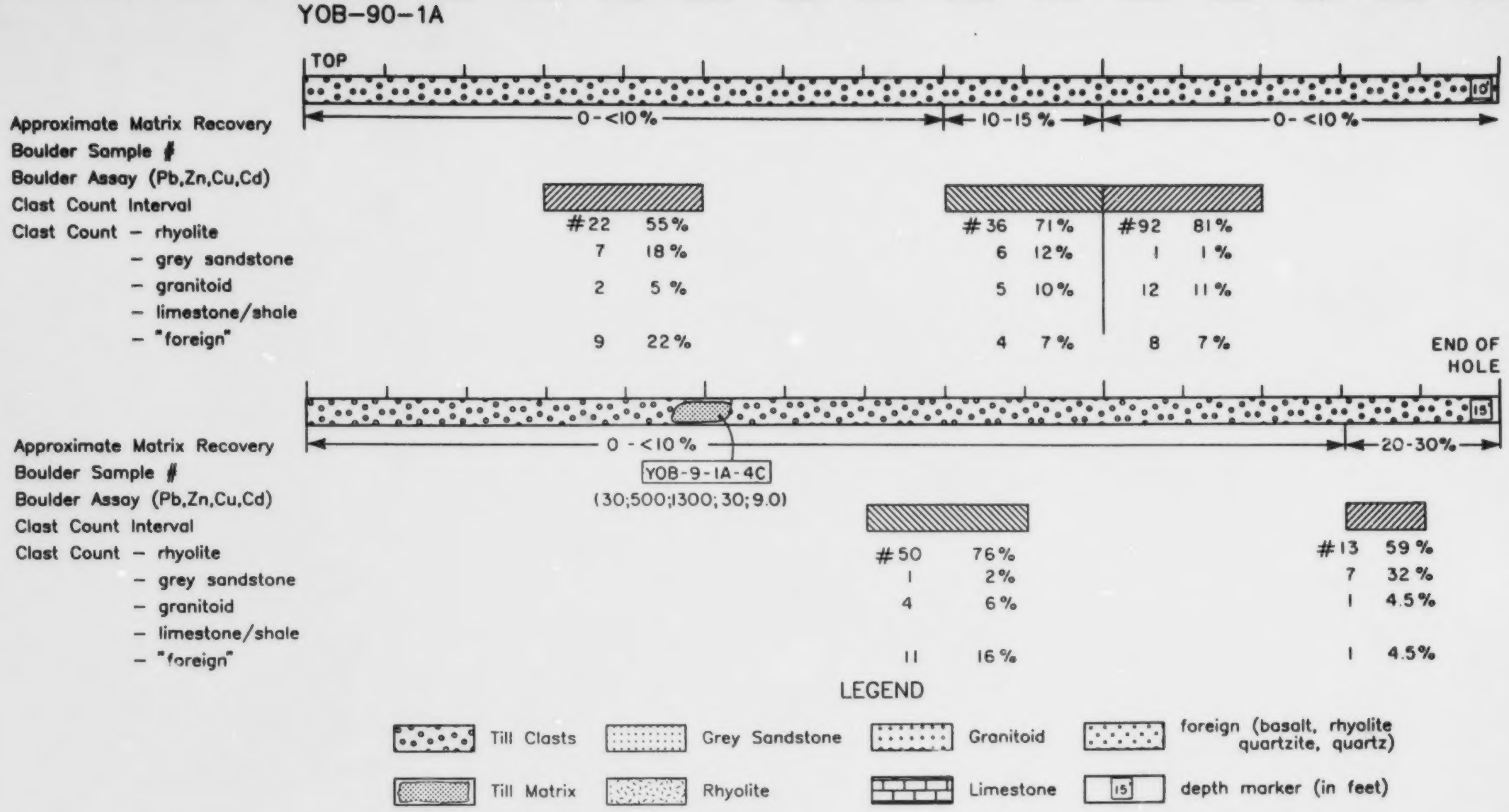
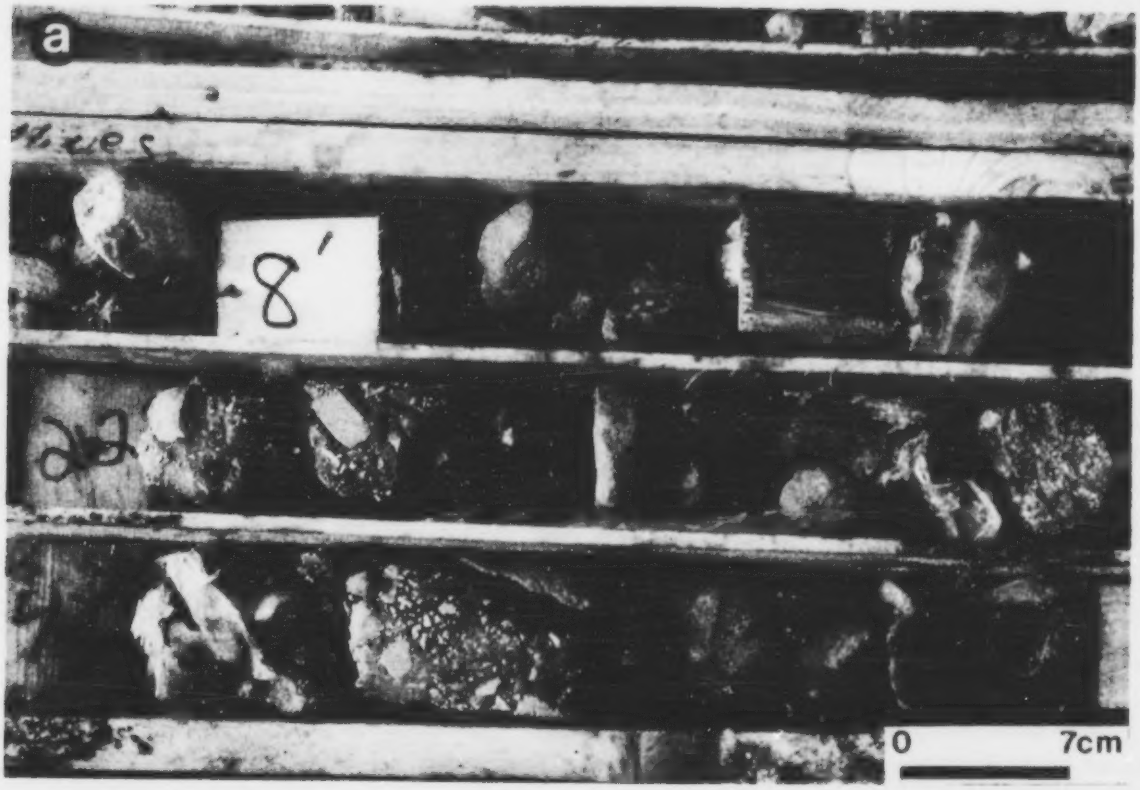
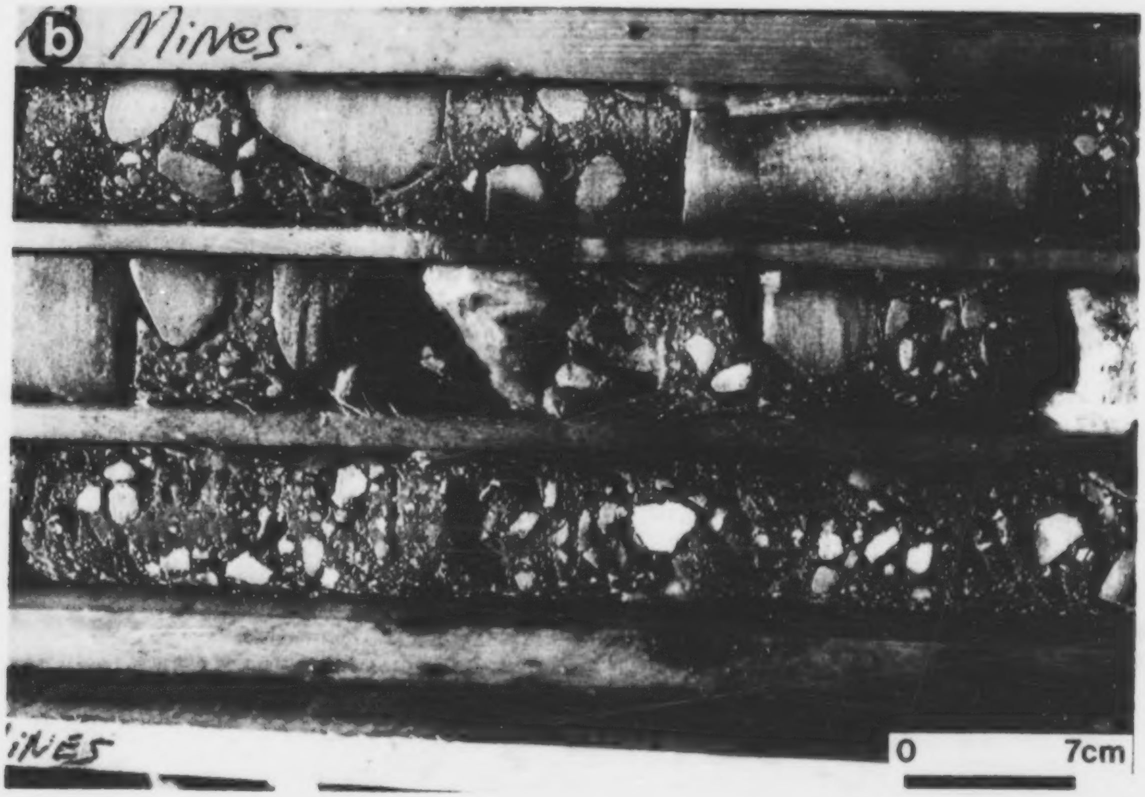

YOB–90–1A
TOP
10
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
0-<10%
10-15%
0-<10%
#22 55%
7 18%
2 5%
9 22%
#36 71%
6 12%
5 10%
4 7%
#92 81%
1 1%
12 11%
8 7%
END OF HOLE
15
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
0 - <10%
20-30%
YOB-9-1A-4C
(30;500;1300;30;9.0)
#50 76%
1 2%
4 6%
11 16%
#13 59%
7 32%
1 4.5%
1 4.5%
LEGEND
Till Clasts
Grey Sandstone
Granitoid
foreign (basalt, rhyolite quartzite, quartz)
Till Matrix
Rhyolite
Limestone
15
depth marker (in feet)

Figure 11. Log of overburden diamond drill hole YOB-90-1A showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

Plate 1a. Typical core recovery from upper sandy ground moraine (i.e. unit 2b of Grant, 1988). Note the total absence of any till matrix. Clasts are predominantly subangular to subrounded rhyolite porphyry from the nearby Loch Lomond Plutonic Complex.

Plate 1b. Typical core recovery from the middle highly compact, clay-rich till referred to as 2a by Grant (1988). This unit forms the cores of drumlins in the study area. The dominant clast-type is grey sandstone of the Silver Mine Formation. Several boulders show visible galena and pyrite mineralization.


a
Mines
8'
22
0
7cm


b
Mines.
iNES
0
7cm

In light of the results of the first hole the original drilling plan was revised. It was decided that a second hole (YOB-90-2) be collared near the apex of the drumlin (Fig. 10) with hopes of intersecting a more competent till at depth.

A complete log of YOB-90-2 is given in Fig. 11. The results of drilling for the top 6m were very similar to YOB-90-1. This section of the hole was dominated by a sandy till with approximately 65 to 77% rhyolite clasts. No matrix was recovered except for a 10cm section near 3.6m depth. As in YOB-90-1A, this is presumably from liquefaction of the loose sandy till matrix by drilling fluids. A clast count from this zone indicated much higher sandstone (35%) and lower rhyolite (18%) components. Between 6 and 18.5m a highly compacted, reddish-brown clay-rich till was intersected. Matrix recovery for most of this interval increased to 80 to 100% as shown in Plate 1b. However, a few matrix-poor zones were encountered (e.g. 13.7m, 14.5m, 16m). Rhyolite clasts in these zones increased to 75% of the total. Several mineralized boulders with visible galena and pyrite were noted. Analysis of these boulders returned significant concentrations of Pb and Zn. For example YOB-90-2-13.9c contains 13 500 ppm Pb and sample YOB-90-2-14.4c contains 5100 ppm Pb, 9400 ppm Zn and 100 ppm Cd. Below 18.5m a loosely compacted, sand-rich till was encountered. Matrix recovery mostly fluctuated between nil and 20% with up to 40% in a 50 cm zone near 26m depth. Sandstone clasts in this narrow zone accounted for 50% of the total, in contrast to 6 to 30% in the remainder of the lower zone (i.e. 18.5 to 31m). Rhyolite clasts in this lower till mostly ranged from 33 to 50%. No mineralized boulders of sandstone were noted. This lower till is considered to be somewhat intermediate between the upper tills in terms of matrix recovery and clast composition. At approximately 28.5 m the drill bit became oversized and a boulder lodged in the core barrel and the hole had to be abandoned.

On the basis of the moderate success of YOB-90-2 a third hole YOB-90-3 was collared approximately 250 m to the west (Fig. 10). The main purpose of this hole was to test the lateral continuity of the lower two till sheets.

A complete log of YOB-90-3 is given in Fig. 11. Once again the loosely-compacted, sandy ground moraine with mostly rhyolite clasts was intersected for the top 6 m of the hole. As in YOB-90-2, at 6m a second highly-compacted till was encountered. Matrix recovery increased to $\geq$70% and the percentage of sandstone clasts increased to $\geq$50%. However, unlike YOB-90-2 this till only extended to 7m where the recovery dropped to 10 to 30% with local zones to 80 to 90% (e.g. 12.8m). From 7 to 25.5 m a hybrid till, similar to that in the lower part of YOB-90-2 was encountered. Several boulders with visible sulphide mineralization were noted throughout this section of the till. Analysis of these boulders returned significant concentrations of Pb, Zn and Cd (Fig. 11). In particular, sample YOB-90-3-15.8c which was collected from two small greenish sandstone boulders contains 25600 ppm Pb, 26500 ppm Zn and 145 ppm Cd.

The results from the overburden drilling confirm the proposed glacial stratigraphy of Grant (1988). That is, the entire area is blanketed by a sandy ground moraine that is approximately 6->7m in thickness (unit 2b) whereas the drumlins are cored by a highly compacted till (unit

2a). Our work indicates that there is a third, lowermost till sheet that is somewhat intermediate in composition. This till has not previously been reported in this region. The exact ice-flow directions cannot be determined from the results of our drilling. Nonetheless, the presence of mineralized boulders throughout the three till sheets suggests that all tills were deposited by ice flows with a strong northeast directional component. This contradicts the proposed ice flows of Fortescue and Hornbrook (1969) where the two till sheets were deposited by opposite, northeast and southwest ice directions. Our work suggests that both till sheets 2a and 2b may have been deposited by ice flow phase 3 of Grant (1988).

### 5.4 Geochemistry

Whenever possible, samples of till matrix (mostly 400-800 gms) were collected at 1 m intervals in holes YOB-90-2 and -3. There was no available matrix in YOB-90-1. The locations of all matrix samples are given in Fig. 11. These samples were submitted to the Minerals Engineering Centre at TUNS for sample preparation. All samples were first wet sieved and the non-magnetic heavy mineral separates were extracted according to the procedures described in section 8 of this report. Till matrix samples will be analysed for a suite of trace and major elements in accordance with the procedures outlined in sections 9.1 and 9.2. No analytical results were available at the time of release of this report.

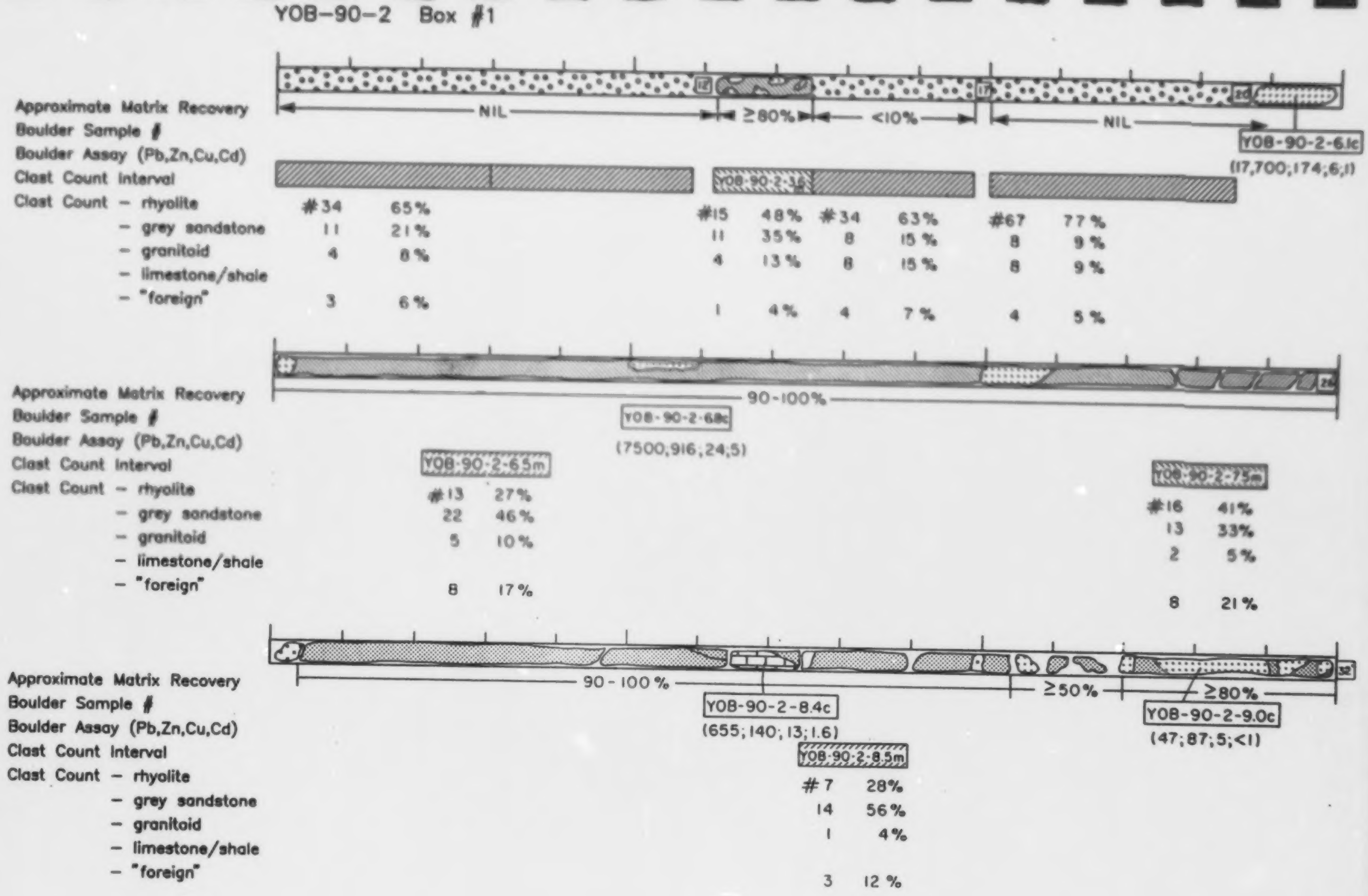

YOB-90-2 Box #1
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
NIL
≥80%
<10%
NIL
YOB-90-2-6.1c
(17,700;174;6;1)
YOB-90-2-3.6
#34 65%
11 21%
4 8%
3 6%
#15 48%
11 35%
4 13%
1 4%
#34 63%
8 15%
8 15%
4 7%
#67 77%
8 9%
8 9%
4 5%
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
90-100%
YOB-90-2-6.8c
(7500;916;24;5)
YOB-90-2-6.5m
#13 27%
22 46%
5 10%
8 17%
YOB-90-2-7.5m
#16 41%
13 33%
2 5%
8 21%
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
90-100%
≥50%
≥80%
YOB-90-2-8.4c
(655;140;13;1.6)
YOB-90-2-8.5m
#7 28%
14 56%
1 4%
3 12%
YOB-90-2-9.0c
(47;87;5;<1)

Figure 11. Log of overburden diamond drill hole YOB-90-2 showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

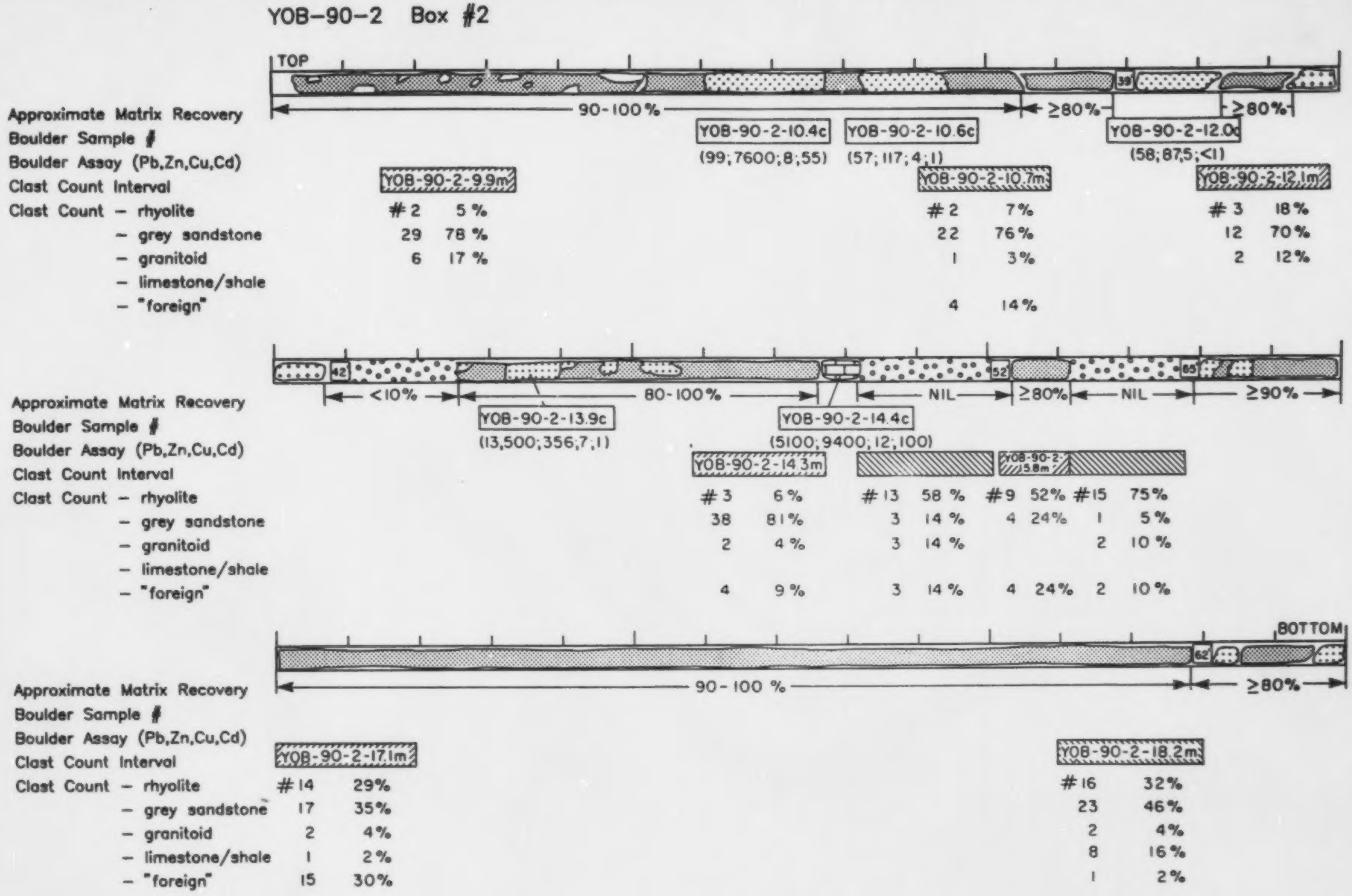

YOB–90–2 Box #2
TOP
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
90-100%
≥80%
≥80%
39
YOB-90-2-10.4c
(99;7600;8;55)
YOB-90-2-10.6c
(57;117;4;1)
YOB-90-2-12.0c
(58;87,5;<1)
YOB-90-2-9.9m
#2 5%
29 78%
6 17%
YOB-90-2-10.7m
#2 7%
22 76%
1 3%
4 14%
YOB-90-2-12.1m
#3 18%
12 70%
2 12%
42
52
65
<10%
80-100%
NIL
≥80%
NIL
≥90%
YOB-90-2-13.9c
(13,500;356;7;1)
YOB-90-2-14.4c
(5100;9400;12;100)
YOB-90-2-14.3m
YOB-90-2-15.8m
#3 6%
38 81%
2 4%
4 9%
#13 58%
3 14%
3 14%
3 14%
#9 52%
4 24%
4 24%
#15 75%
1 5%
2 10%
2 10%
BOTTOM
62
90-100%
≥80%
YOB-90-2-17.1m
#14 29%
17 35%
2 4%
1 2%
15 30%
YOB-90-2-18.2m
#16 32%
23 46%
2 4%
8 16%
1 2%

Figure 11 Log of overburden diamond drill hole YOB-90-2 showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

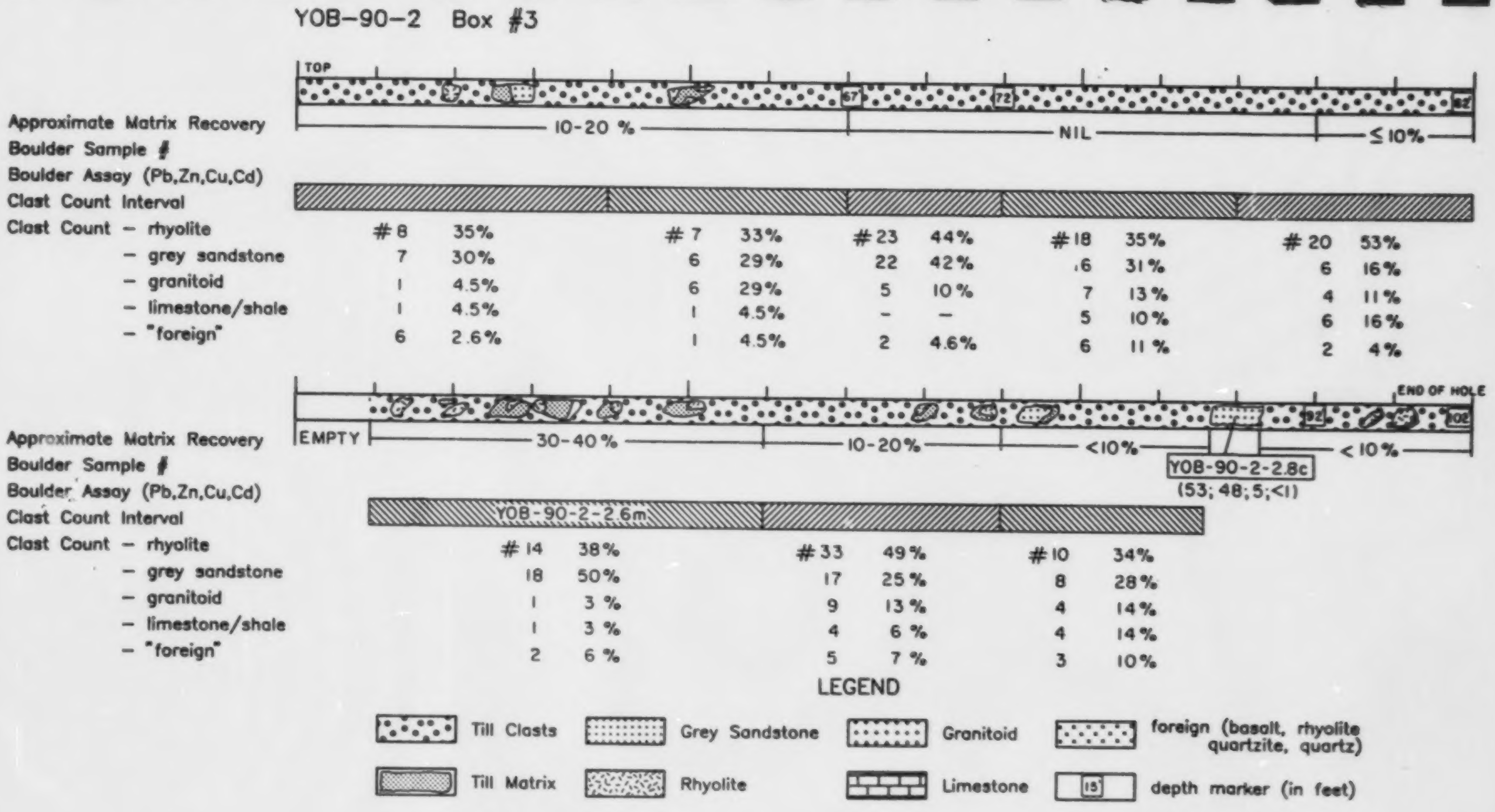

YOB-90-2 Box #3
TOP
67
72
82
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
10-20 %
NIL
≤ 10%
#8 35%
7 30%
1 4.5%
1 4.5%
6 2.6%
#7 33%
6 29%
6 29%
1 4.5%
1 4.5%
#23 44%
22 42%
5 10%
– –
2 4.6%
#18 35%
6 31%
7 13%
5 10%
6 11 %
#20 53%
6 16%
4 11%
6 16%
2 4%
END OF HOLE
92
102
EMPTY
30-40 %
10-20%
<10%
< 10%
YOB-90-2-2.8c
(53; 48; 5; <1)
YOB-90-2-2.6m
#14 38%
18 50%
1 3 %
1 3 %
2 6 %
#33 49%
17 25 %
9 13 %
4 6 %
5 7 %
#10 34%
8 28%
4 14%
4 14%
3 10%
LEGEND
Till Clasts
Grey Sandstone
Granitoid
foreign (basalt, rhyolite quartzite, quartz)
Till Matrix
Rhyolite
Limestone
15
depth marker (in feet)

Figure 11. Log of overburden diamond drill hole YOB-90-2 showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

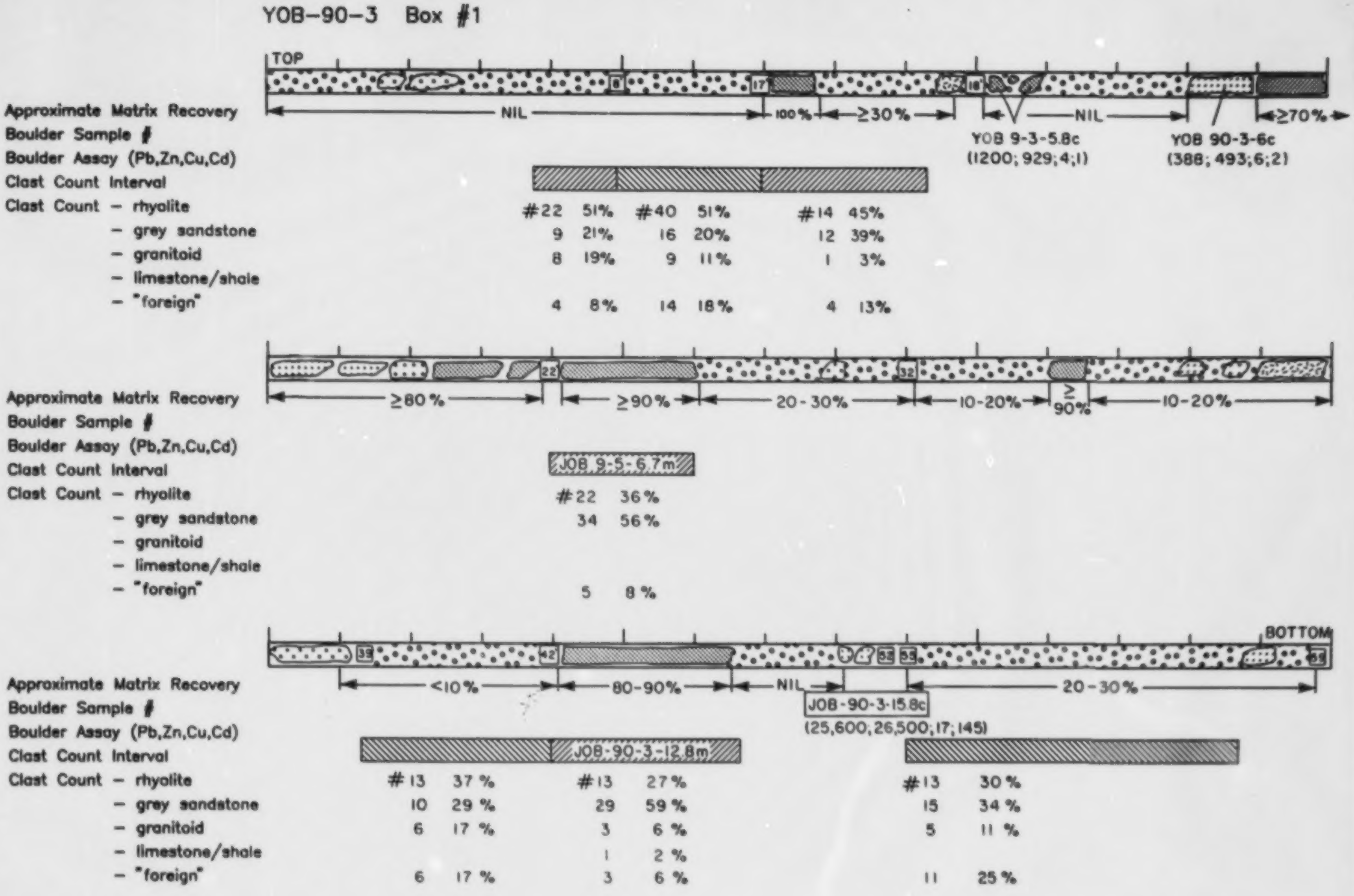

YOB–90–3 Box #1
TOP
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
NIL
100%
≥30%
NIL
≥70%
8
17
18
YOB 9-3-5.8c
(1200; 929; 4; 1)
YOB 90-3-6c
(388; 493; 6; 2)
#22 51% #40 51% #14 45%
9 21% 16 20% 12 39%
8 19% 9 11% 1 3%
4 8% 14 18% 4 13%
≥80%
≥90%
20-30%
10-20%
≥ 90%
10-20%
22
32
JOB 9-5-6.7m
#22 36%
34 56%
5 8%
BOTTOM
<10%
80-90%
NIL
20-30%
39
42
52
53
59
JOB-90-3-15.8c
(25,600; 26,500; 17; 145)
JOB-90-3-12.8m
#13 37% #13 27% #13 30%
10 29% 29 59% 15 34%
6 17% 3 6% 5 11%
1 2%
6 17% 3 6% 11 25%

Figure 11. Log of overburden diamond drill hole YOB-90-3 showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

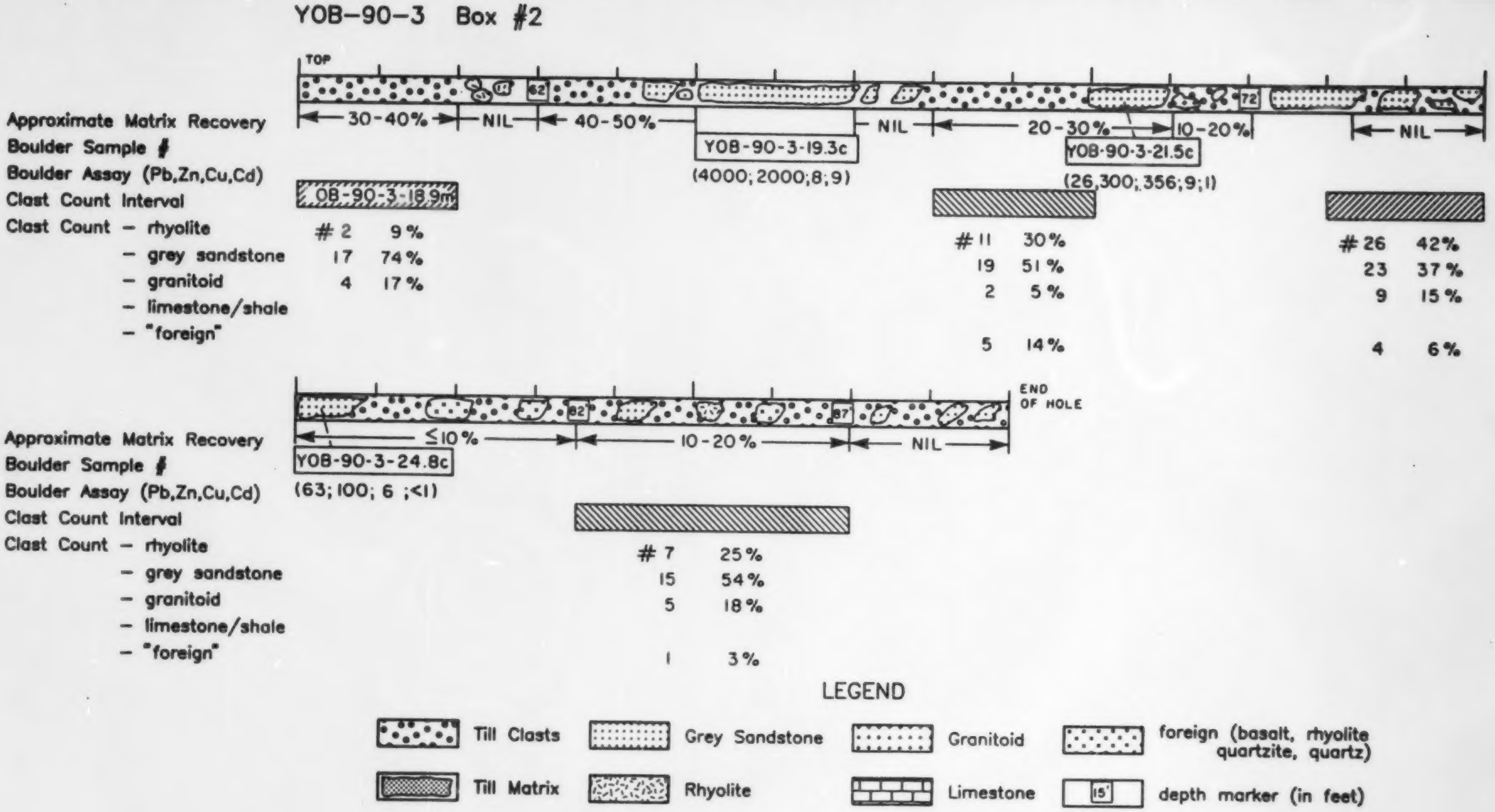

YOB-90-3 Box #2
TOP
Approximate Matrix Recovery
Boulder Sample #
Boulder Assay (Pb,Zn,Cu,Cd)
Clast Count Interval
Clast Count – rhyolite
– grey sandstone
– granitoid
– limestone/shale
– "foreign"
30-40%
NIL
40-50%
NIL
20-30%
10-20%
NIL
62
72
YOB-90-3-19.3c
(4000;2000;8;9)
YOB-90-3-21.5c
(26,300;356;9;1)
OB-90-3-18.9m
# 2 9%
17 74%
4 17%
# 11 30%
19 51%
2 5%
5 14%
# 26 42%
23 37%
9 15%
4 6%
≤10%
10-20%
NIL
82
87
END OF HOLE
YOB-90-3-24.8c
(63;100;6;<1)
# 7 25%
15 54%
5 18%
1 3%
LEGEND
Till Clasts
Till Matrix
Grey Sandstone
Rhyolite
Granitoid
Limestone
foreign (basalt, rhyolite quartzite, quartz)
15'
depth marker (in feet)

Figure 11. Log of overburden diamond drill hole YOB-90-3 showing the approximate matrix recovery and till clast composition. Assay values for Pb, Zn, Cu and Cd are given for selected boulders.

# 6 GRID SAMPLING

## 6.1 Grid design and sampling methodology

Prior to designing a sampling grid several factors were considered. Firstly, the location of subcropping ore associated with the three main zones and any auxiliary mineralized zones had to be established. This was achieved by evaluating drill hole information from the Yava deposit (M. Grice, pers. comm.). The second consideration was the direction(s) of major ice flow in the vicinity of the deposit. As stated above, the most extensive glacial study was that of Grant (1988). He concluded that the major ice flow direction was to the northeast. Thirdly, the amount of dispersion associated with the major ice flow(s) must be considered when designing the grid dimensions. No definitive studies of dispersal characteristics of the till(s) clasts and/or matrix have been conducted in the Yava area. It was therefore necessary to make inferences from previous studies. Boner et al., (1990) conducted a regional geochemical till survey over the South Mountain Batholith of southwestern Nova Scotia. They concluded that a 2 km grid sample spacing was sufficient to establish general till dispersal characteristics and delineate anomalous areas but a closer spacing was clearly required to further define individual anomalies. The final factor to be considered was the results of previous geochemical studies. An evaluation of previous soil (Geisler, 1963), biogeochemical (Fortescue and Hornbrook, 1969) and stream sediment data (Rogers and MacDonald, 1986) indicates the presence of a "belt" with strong enrichment in Pb and Zn that crudely corresponds to the basement/basin contact zone.

In light of the above criteria a 2 x 2 km sampling grid was centred over the subcrop of the east ore zone (Fig. 10). No significant mineralized zones have been delineated by production-related drilling (Sangster and Vaillancourt, 1990) in the region "down-ice" or northeast of the east zone. Therefore any resulting northeast-trending anomalies should consequently be attributed to clastic and/or hydromorphic dispersion from subcropping mineralization and not to "down-ice" bedrock sources. Geochemical data from the grid sampling in this study will be useful in establishing the optimal sample spacing (to a maximum of 2 km) for regional till, soil, humus and biogeochemical surveys in the GHG and LLB.

A total of 62 samples were collected on approximately 250 m spacing throughout the grid. Wherever possible, samples were collected along road cuts and Crown Survey cut lines. The resulting sample distribution is shown in Fig. 10. Note individual stations are denoted by their distance, in metres, both N-S and E-W from a central point (0 N, 0 E). Specimens collected at each site included: 1) Balsam Fir (Abies balsamea) and/or black spruce (Picea mariana) depending upon species availability. Approximately 5 branches with past 5- to 7-year growth from single Balsam Fir and/or black spruce trees were placed into large (approx 25 x 35 cm) brown craft bags; 2) "$A_1$" horizon (i.e. organic humus) was placed into 2 small (approximately 7 x 25 cm) brown craft bags; 3) approximately 3-5 kg of clasts (>1 cm) and approximately 5 kg of matrix (<1 cm) were separated from "unweathered" till samples (0.8-1.2 m depth) in hand-dug burrow pits. Sample preparation procedures for each of the media are presented in section 8 of this report.

## 6.2 Stream sediment sampling methodology

A north- and northeast-trending first- and second-order stream crosses the central portion of the Yava grid (Fig. 10). Rogers and MacDonald (1986) reported analyses for two samples from this stream. The first was collected immediately upstream (i.e. south) of the Salmon River Road and the second was collected near the fork of this stream with the Salmon River. The sample above the road returned an elevated value for Pb (1000 ppm) compared to the regional data (see *above) whereas the downstream sample had a much lower value (280 ppm Pb). Only the upstream sample had an elevated value of Ag (0.3 ppm) when compared to data from the central portion of the GHG and LLB. Neither of the samples contained elevated values of Zn or Cu. This stream was not sampled during the regional survey of Mills (1989).

Nine samples were collected along the stream at approximately 250 m spacing. Several low-lying, swampy areas were encountered and sample sites had to be adjusted accordingly (Fig. 10). Sample preparation procedures are given in section 8 of this report.

## 7 TILL CLAST VARIATION IN SANDY GROUND MORAINE

As stated above, approximately 3-5 kg of clasts (generally >1-5 cm) was collected at each of the grid location when till was available. Till was collected below the oxidized or B-horizon, as defined by a prominent colour change (mostly orangish to pinkish, greyish or brownish). This till is considered to be fresh or "unweathered", although the possibility of physico-chemical modification(s) from surficial processes cannot be ruled out. The locations of the 58 clast samples is given in Fig. 10. Large boulders were split with a hammer and a small fragment was retained. The clasts were subsequently washed and separated into 5 subsets based upon lithology including rhyolite, grey sandstone, granite, brown sandstone and "foreign" (mostly mafic and felsic volcanics and metasediments). The respective numbers of these lithotypes was then counted and are given in Table 3. Contoured plots were then prepared using the Rockware data plotting package on an IBM-compatible microcomputer and are presented in Figs. 12a to e. This contouring package was also used to generate all of the contour plots used in this report.

The most striking feature of the clast distribution in the sandy ground moraine is the predominance of grey sandstone (up to $\geq$90%; Fig. 12a) in the northern part of the grid and the predominance of pink to red rhyolite clasts (up to $\geq$90%; Fig. 12b) in the southern part of the grid. Minor amounts of brown sandstone clasts occur at the transition zone between rhyolite- and grey sandstone-dominated till in the central part of the grid with the highest concentrations noted in the northeast corner of the grid (Fig. 12c). Percentages of both granite and "foreign" clasts show no systematic distribution within the grid (Figs. 12d and e).

The grey sandstone and rhyolite clast content of the sandy ground moraine generally reflects the bedrock geology of Boehner and Prime (1985; Fig. 13), however, a few differences are evident. Boehner and Prime (1985) indicate the presence of a rhyolite basement ridge near 0 N,0E in the grid which is marked by the termination of the McKeigan Lake Formation. They concluded that the ridge of rhyolite did not extend more than a few tens of metres to the north. In contrast our data suggests that this basement feature may in fact extend up to 300 m to the north to just north of 250N, 0E. Sangster and Vaillancourt (1990) indicate the presence of a basement rhyolite ridge in this area that is thinly blanketed by Silver Mine Formation sandstone (Fig. 3) which controls the distribution of high-grade mineralization. Our data suggests that this ridge may be partially or wholly exposed. The other significant deviation from the bedrock geology of Boehner and Prime (1985) and Sangster and Vaillancourt (1990) is in the southwestern corner of the grid where >50% grey sandstone clasts extend to 250 S, 500 W suggesting that the Silver Mine Formation sandstones extend for approximately 250 m south of the previously mapped sandstone/rhyolite.

The north-trending steep gradients in sandstone/rhyolite clast proportions in the southwestern portion of the grid would not be obtained if northeast glacial clast dispersion exceeded, say, 250 metres. This implies that the clasts have a very local provenance. This proximal nature may also be reflected in the till matrix which will have implications for interpretation of the matrix geochemistry (Turner and Stea, 1990). However, a study of the relationship between till clasts and matrix in southwestern Nova Scotia (Graves et al., 1988) has documented significant dispersal in till matrix with extremely small renewal distances ($\leq$100 m) for clasts. The relationship between till clasts and till matrix will be discussed below.

Both granite and "foreign" clasts are unevenly distributed throughout the grid. This indicates that these clast types may have a distal provenance (e.g. greater than several km). The observed distribution of these clasts may represent reworking of clasts from the underlying clay-rich highly compacted till (unit 2a of Grant, 1988).

The origin of the brown sandstone clasts is problematic. These clasts have a dark brown colour and are characteristically poorly indurated and are easily disagregated with gentle hand pressure. These clasts often appear to be manganiferous and leave a blackish brown stain when handled. They were initially assumed to be part of the McKeigan Lake Formation since their appearance was repeatedly noted at the rhyolite/sandstone transition in the field. However, this type of lithology is generally not attributed to any particular Carboniferous Formation (Boehner pers. comm., 1990). Additionally the high concentration of brown sandstone in the northeast corner of the sample grid is not consistent with the drill-indicated bedrock geology. These clasts could result from weathering processes within the till sheet, however, they were consistently found in tills containing competent grey sandstone and reddish rhyolite clasts suggesting a primary bedrock source. It is possible that the bedrock may have undergone extensive weathering to generate these manganiferous clasts. At present the origin of these poorly indurated sandstone clasts remains unknown.

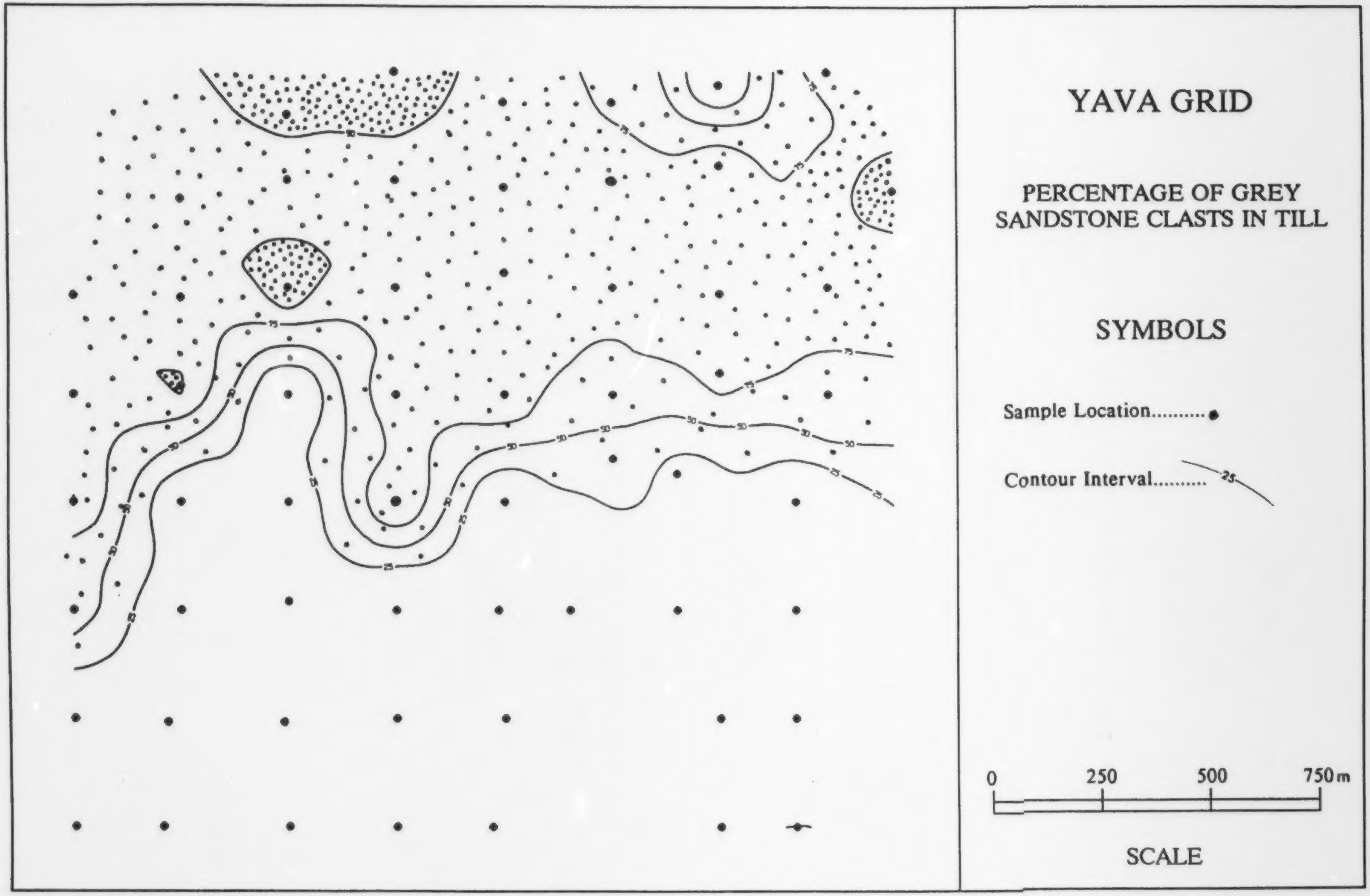

YAVA GRID
PERCENTAGE OF GREY SANDSTONE CLASTS IN TILL
SYMBOLS
Sample Location.......... ●
Contour Interval.......... 25
0
250
500
750 m
SCALE
75
50
25

Figure 12a

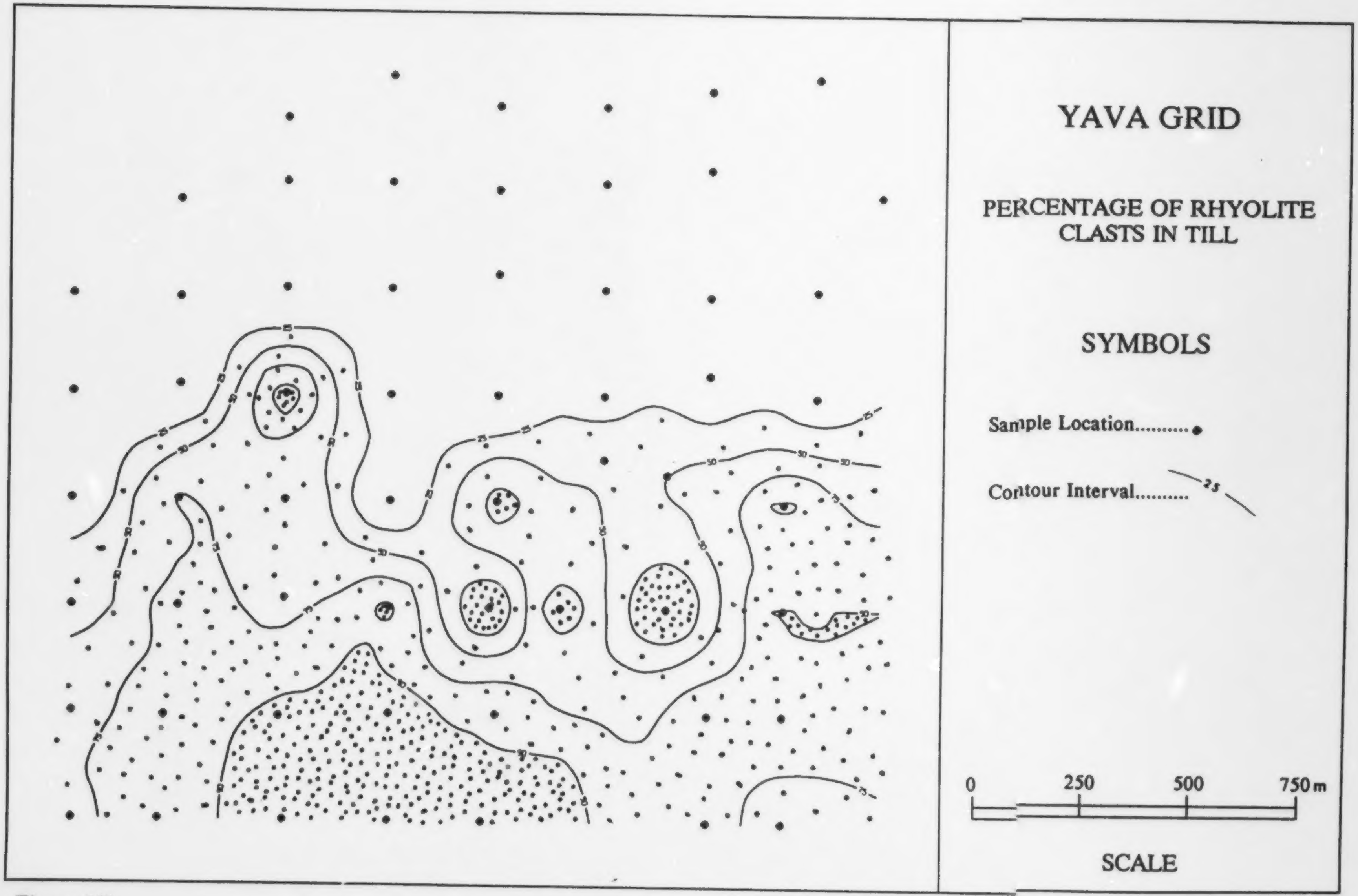

YAVA GRID
PERCENTAGE OF RHYOLITE CLASTS IN TILL
SYMBOLS
Sample Location..........
Contour Interval..........
25
0
250
500
750 m
SCALE

Figure 12b

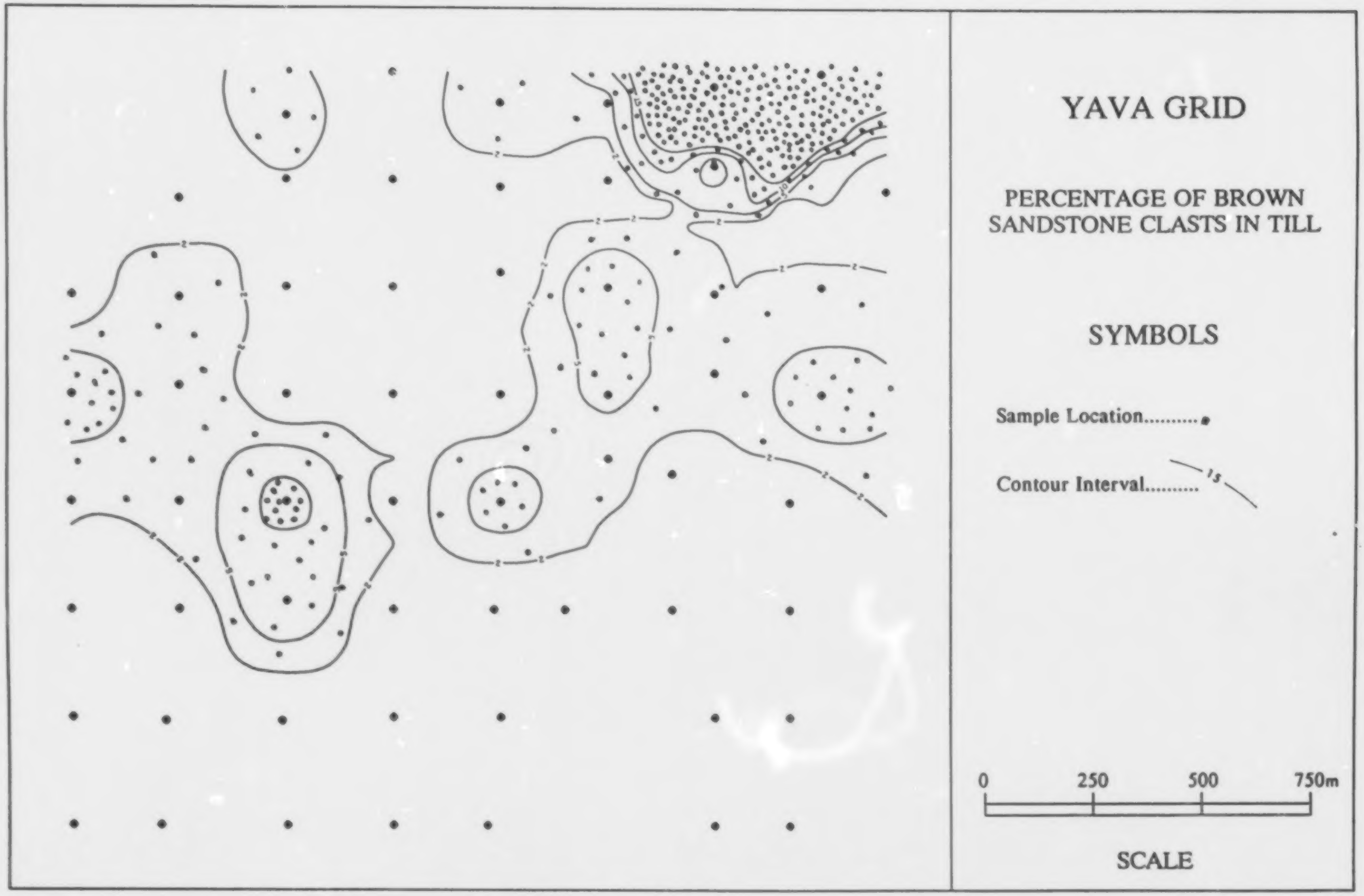

YAVA GRID
PERCENTAGE OF BROWN SANDSTONE CLASTS IN TILL
SYMBOLS
Sample Location..........
Contour Interval..........
15
2
5
10
0
250
500
750m
SCALE

Figure 12c

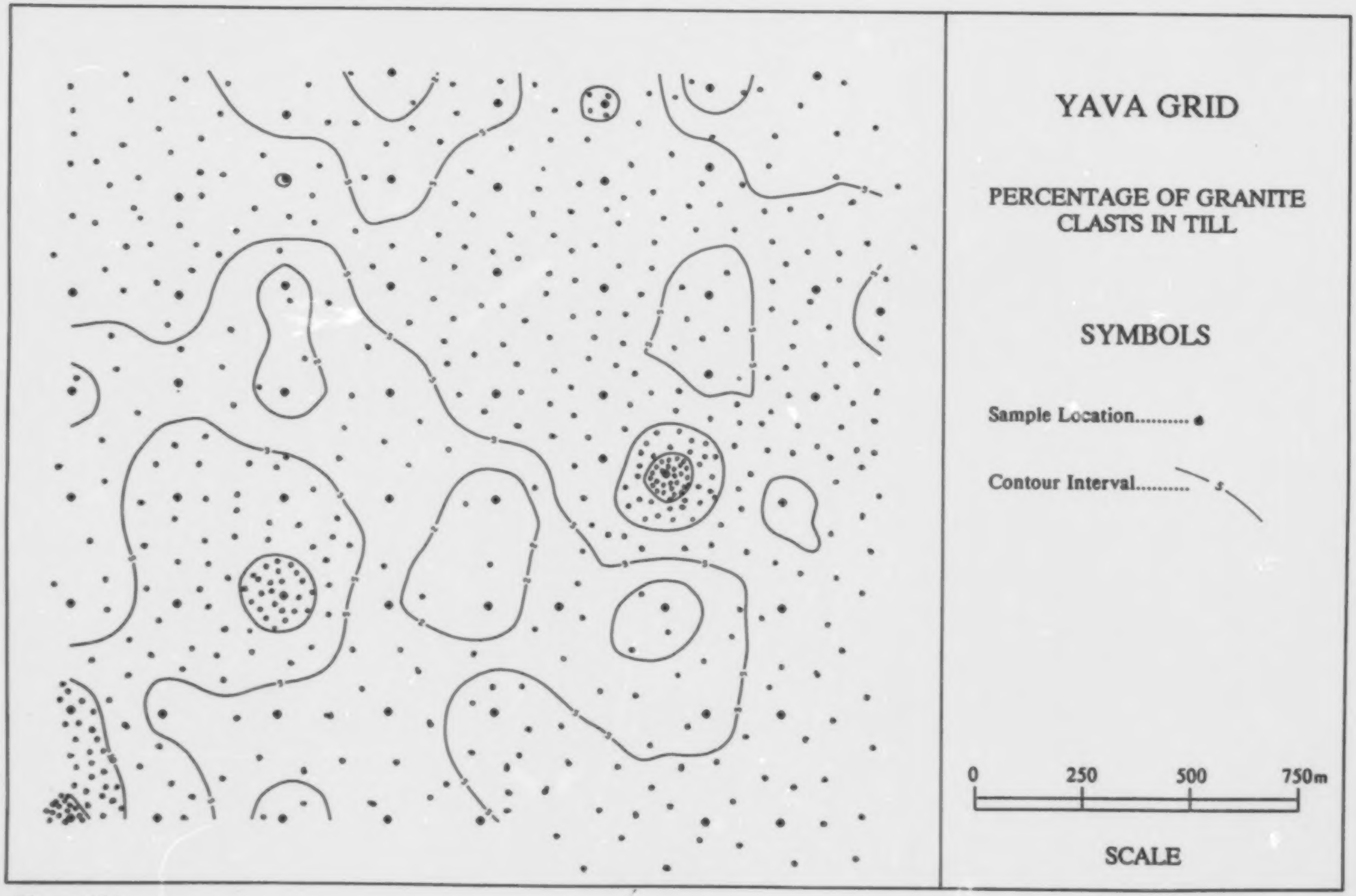

YAVA GRID
PERCENTAGE OF GRANITE CLASTS IN TILL
SYMBOLS
Sample Location..........
Contour Interval..........
5
0
250
500
750m
SCALE

Figure 12d

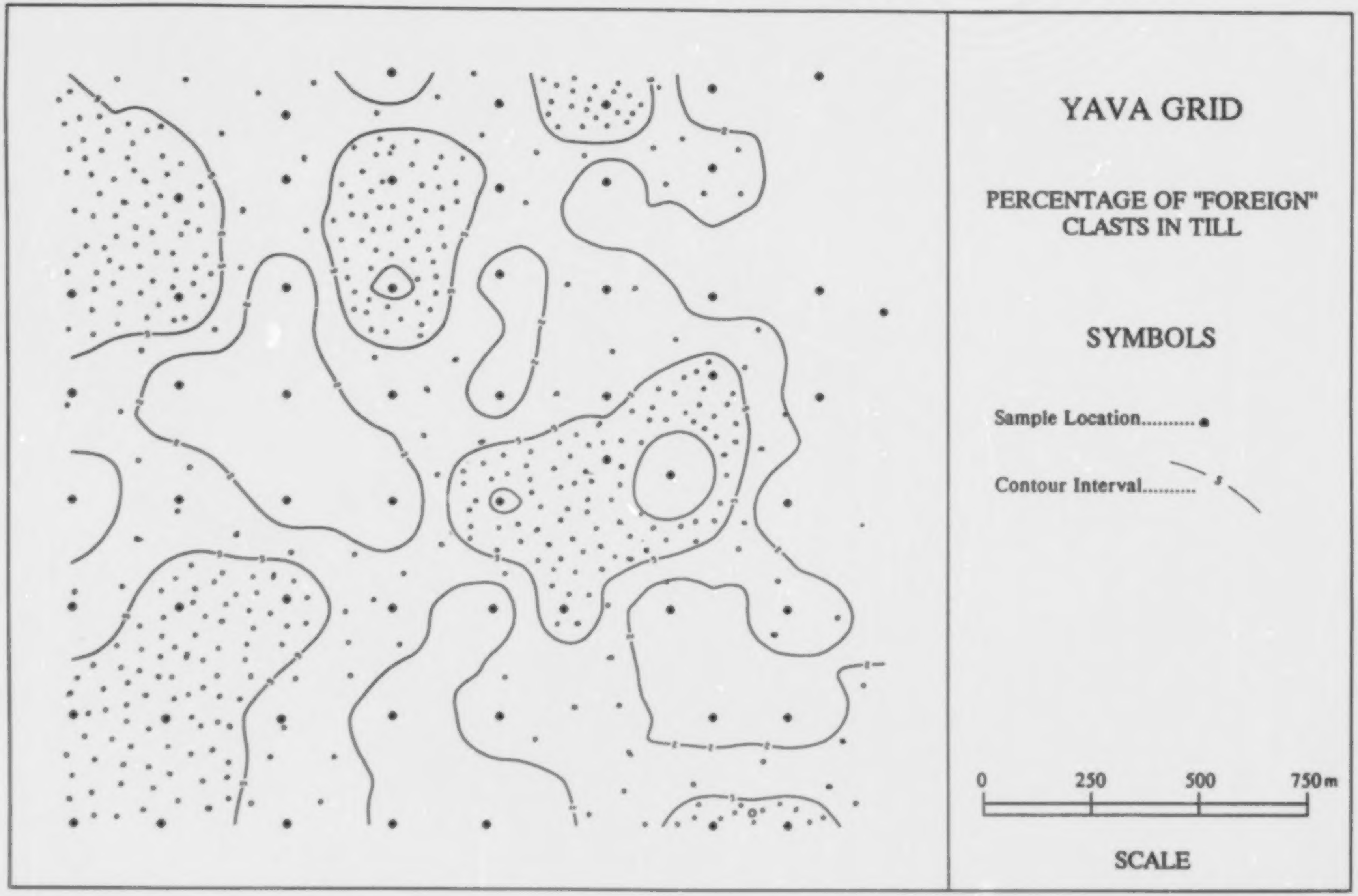

YAVA GRID
PERCENTAGE OF "FOREIGN" CLASTS IN TILL
SYMBOLS
Sample Location.......... ●
Contour Interval..........
0
250
500
750 m
SCALE

Figure 12e

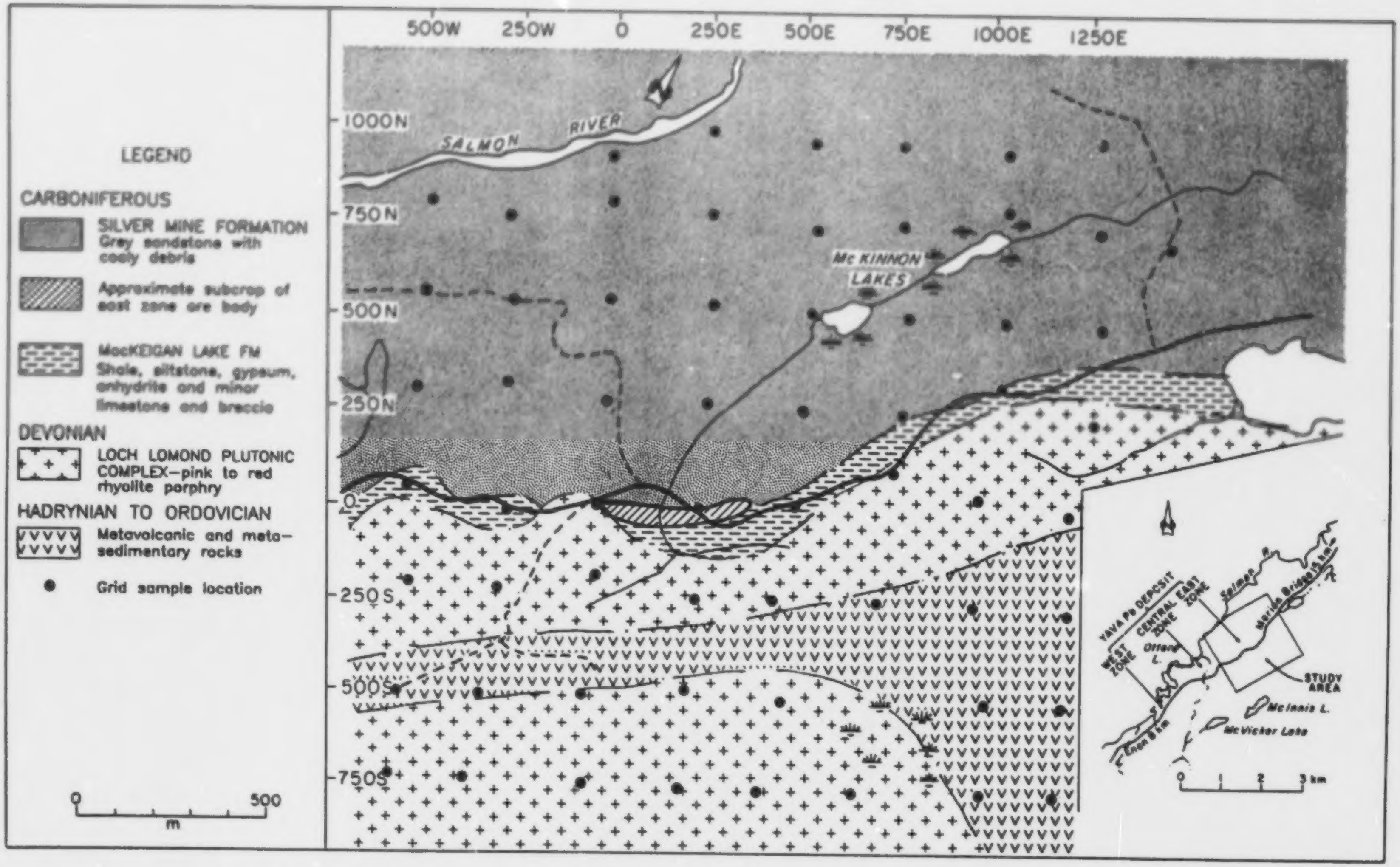

500W
250W
0
250E
500E
750E
1000E
1250E
1000N
750N
500N
250N
0
250S
500S
750S
SALMON RIVER
Mc KINNON LAKES
LEGEND
CARBONIFEROUS
SILVER MINE FORMATION Grey sandstone with coaly debris
Approximate subcrop of east zone ore body
MacKEIGAN LAKE FM Shale, siltstone, gypsum, anhydrite and minor limestone and breccia
DEVONIAN
LOCH LOMOND PLUTONIC COMPLEX—pink to red rhyolite porphyry
HADRYNIAN TO ORDOVICIAN
Metavolcanic and meta-sedimentary rocks
Grid sample location
0
500
m
YAVA Pb DEPOSIT
WEST ZONE
CENTRAL ZONE
EAST ZONE
Salmon R.
Marion Bridge 15 km
Ottawa L.
Enon 8 km
STUDY AREA
McInnis L.
McVicker Lake
0
1
2
3 km

Figure 13. Detailed bedrock geology of the grid area (from Boehner and Prime, 1985) showing the distribution of formations and approximate location of the subcrop of the east ore zone.

# 8 SAMPLE PREPARATION

All sample preparation procedures for this survey were conducted at the Minerals Engineering Centre at TUNS in Halifax, Nova Scotia. The following sections outline the specific techniques that were employed.

## 8.1 Till matrix and stream sediments

Till matrix and stream sediment samples received the same sample preparation procedures. A flow chart of these procedures is given in Fig. 14. The first step was to wet sieve the samples into -230, -60+230 and +60 mesh (-62.5, -250+62.5 and +250 μm) size fractions which were subsequently dried in an oven at 110°C for 12 hours. Each fraction was then weighed. The +60 fractions were placed in plastic bags and placed in archival storage. Subsamples of the -230 (-62.5 μm) fractions were placed into 30 ml plastic vials and submitted for major and trace element analysis by ICP-AES (see below). The excess material was placed in 500 ml wide-mouth jars and placed in storage.

Approximately 500 gms from the -60+230 mesh (-250+62.5 μm) fractions were used for heavy liquid separation with tetrabromethane (2.95 S.G.). The "light minerals" (<2.95 S.G.) were placed in plastic bags and archived. The "heavy minerals" (>2.95 S.G.) were ultrasonically cleaned in acetone and air-dried. They were then separated into magnetic and non-magnetic fractions using a specially-designed, hand-held magnet. The magnetic fraction, which mostly contains magnetite with subordinate ilmenite and pyrrhotite, was placed in 30 ml vials and archived. This procedure reduces the amount of Fe in the heavy mineral concentrate which may cause interferences in some analytical techniques, particularly in Instrumental Neutron Activation Analysis (INAA). Approximately 0.1 gm of the non-magnetic fraction was placed in small glass vials and will be used for future mineral identification studies. The remainder of the non-magnetic fraction was sent to Chemex Laboratories in North Vancouver, British Colombia where they were crushed to approximately 150 mesh (-100μm) prior to analysis for major and trace elements (see below).

## 8.2 Balsam Fir

A flow chart for the sample preparation procedures used for Balsam Fir is given in Fig. 15. The Balsam Fir branches were air dried in their kraft bags to remove most of their moisture. The needles which characteristically contain lower concentrations of most trace elements were then stripped from the branches by hand and stored in plastic bags for possible future use. The branches were then placed in ceramic trays and heated for 4 hours at 500°C in a furnace. Several samples still contained minor amounts of charcoal-like material following heating so they had to be re-ashed. It is suggested that the ashing technique of Dunn et al. (1989) be employed in future biogeochemical surveys. Ashing of biogeochemical samples, such as Balsam Fir twigs, reduces the sample volume and hence increases the concentration of non-volatile elements (Dunn, 1991). This preconcentration procedure will give better

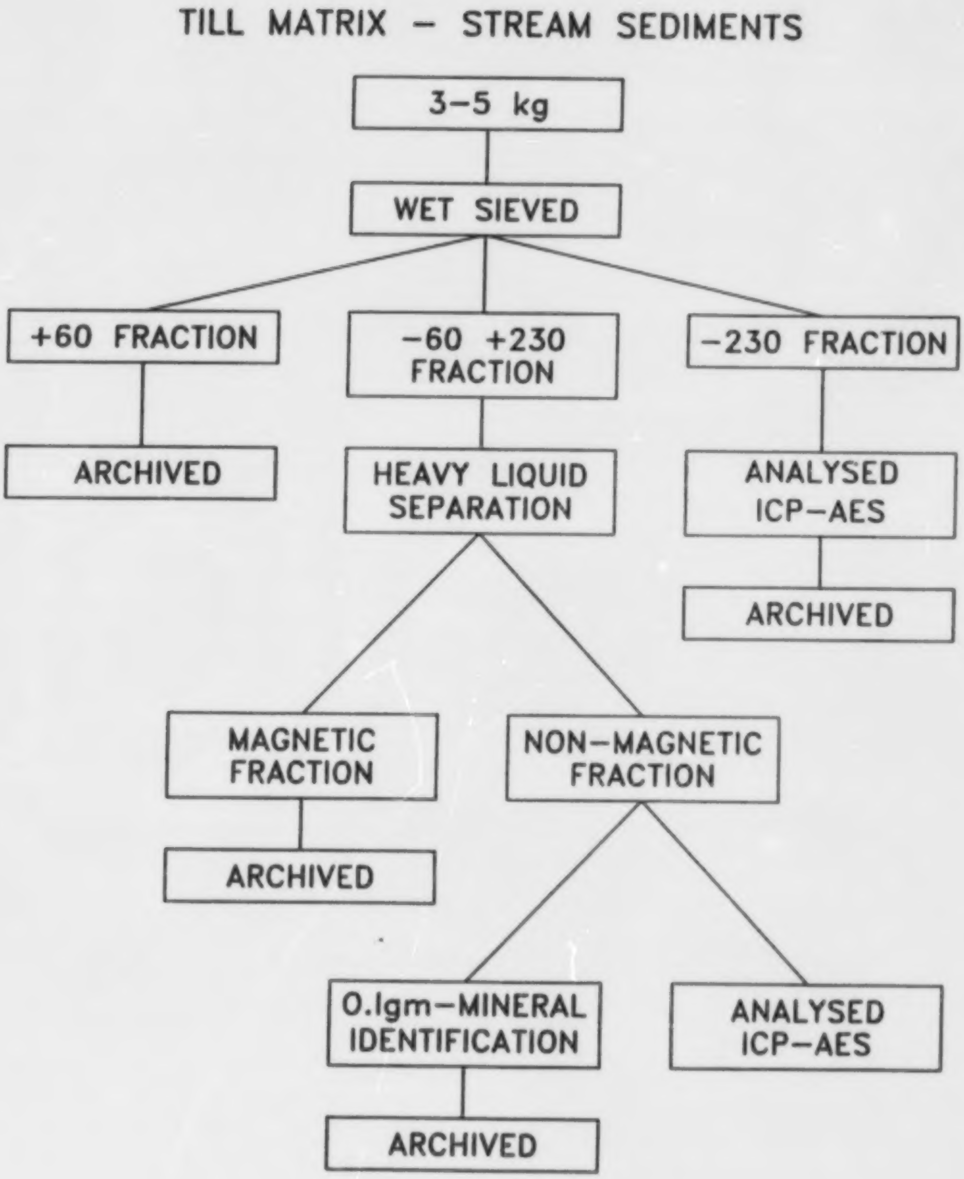

TILL MATRIX – STREAM SEDIMENTS
3–5 kg
WET SIEVED
+60 FRACTION
−60 +230 FRACTION
−230 FRACTION
ARCHIVED
HEAVY LIQUID SEPARATION
ANALYSED ICP–AES
ARCHIVED
MAGNETIC FRACTION
NON–MAGNETIC FRACTION
ARCHIVED
O.lgm–MINERAL IDENTIFICATION
ANALYSED ICP–AES
ARCHIVED

Figure 14. Flow chart outlining sample preparation procedures for till matrix and stream sediment samples.

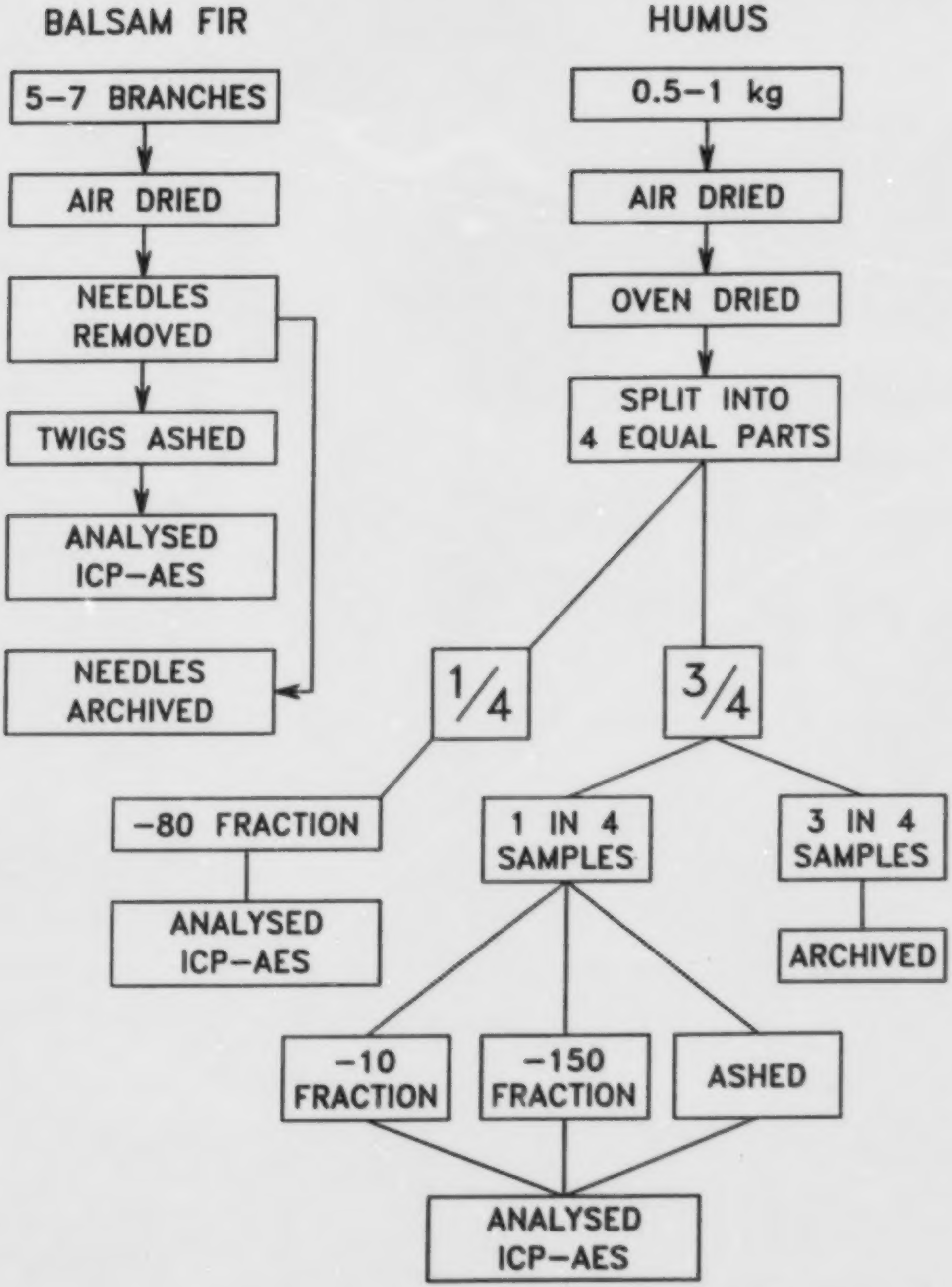

BALSAM FIR
5-7 BRANCHES
AIR DRIED
NEEDLES REMOVED
TWIGS ASHED
ANALYSED ICP-AES
NEEDLES ARCHIVED
HUMUS
0.5-1 kg
AIR DRIED
OVEN DRIED
SPLIT INTO 4 EQUAL PARTS
1/4
3/4
-80 FRACTION
ANALYSED ICP-AES
1 IN 4 SAMPLES
3 IN 4 SAMPLES
ARCHIVED
-10 FRACTION
-150 FRACTION
ASHED
ANALYSED ICP-AES

**Figure 15.** Flow chart outlining sample preparation procedures for Balsam Fir and humus samples.

precision, particularly for elements that approach detection limits in non-ashed samples.

### 8.3 Humus

The humus samples were first air-dried in their kraft-paper bags and subsequently placed in a furnace at 110°C overnight to remove all moisture. Each sample was then homogenized and divided into four equal portions using a riffle splitter. One portion from every sample was then dry-sieved to -80 mesh (-177 μm) to remove large non-decomposed organic material and any coarse clastic grains. This fraction was then submitted for major and trace element analysis (see below). Two of the remaining portions from every fourth sample were dry-sieved to -10 (-2000 μm) and -150 mesh (-100 μm). The final portion from every fourth sample was placed in a ceramic tray and ashed in a furnace at 500°C until all of the glowing embers and black charcoal was eliminated. This mostly required at least 4 hours of heating. All sieved and ashed samples were placed in 30 ml plastic vials and have been submitted for analysis by the same technique as the -80 mesh (-177 μm) fraction. However, the analytical results were not available at the time of this report and will be described in upcoming reports. The purpose of analysing subsamples produced by different preparation techniques is to establish the optimal sample preparation technique for future programmes.

## 9 ANALYTICAL PROCEDURES AND RESULTS

The following section outlines the various analytical procedures and resulting data for all of the sample media. The data and quality control information is presented in a series of tables in Appendix A at the back of the report.

It was decided that a preliminary evaluation of the data be undertaken. We have generated contour plots for the various sample media from the grid using the Rockware software package, as used for the till clast abundances. We have also generated "bar-type" plots for the stream sediment data according to the method used by Rogers and MacDonald (1984). The chief problem with portraying data in this manner is the estimation of individual contour intervals. In past many workers, for example Rogers and MacDonald (1984), have assigned "threshold" values according to the method of Hawkes and Webb (1962). Threshold is calculated as mean + 2 x Std. Dev. In a normally distributed data set this T would correspond to the 97.5th percentile of the data. Other workers, for example Turner and Stea (1987), used the 95th percentile of their data set to represent an "anomaly level". They then portrayed their data using "star" symbols that corresponded to multiples of these anomaly levels. Some workers have generated trend surface plots for till (Boner et al., 1990) and lake (Rogers and Chatterjee, 1990; Lombard, 1991) surveys where intervals correspond to arbitrarily chosen percentile values, for example 75th, 90th, 95th and 99th percentiles. The major problem with these techniques is that the actual distribution of the data is overlooked. For example a group of "anomalous" data from a potentially mineralized region may constitute a large proportion of the data set, say 30%. If only values in excess of the 95th percentile are considered "anomalous" a large portion of this information may be disregarded. Garret (1991) succinctly summarized this problem and suggests that the proper procedure for allocation of "inspection levels" should involve the distribution of data within the specific survey. He suggests that this can be accomplished by using cumulative frequency or cumulative probability plots to establish "breaks" in the data.

Very few "regional" surveys for the various sample media used in this study are available for either the Glengarry Halh Graben or Loch Lomond Basin. In particular there were no surveys for any sample media where the same sample preparation and analytical techniques were used. It was, therefore, not possible to set anomaly (or inspection) thresholds (or levels) using data from previous surveys with the method suggested by Garret (1991). The authors concluded that a rigorous statistical evaluation of previous survey data from other Carboniferous basins or geological terranes, that used different sample preparation and analytical techniques, would be misleading.

At the time of the release of this preliminary report the authors were investigating the applicability of various statistical techniques to the data from this study. Individual techniques include the use of non-parametric geostatistical (e.g Kriging) and various parametric statistical procedures (e.g. mean, inter-quartile range, cumulative frequency, cumulative probability) to establish inspection levels.

In spite of the above considerations contour plots were generated for each of the sample media. In most cases the data were first ranked in descending order and natural breaks in the data were established. These levels were then used as contour intervals. In the case of the -230 mesh (-62.5 μm) fraction from till matrix and stream sediment the data was contoured using "thresholds" levels corresponding to mean + 2 x Std. Dev. from the data of Turner and Stea (1987) and Rogers and MacDonald (1986). It must be stressed that these plots were produced to permit a preliminary evaluation of the data. The exact contour intervals must not be construed as rigorous statistically-derived "thresholds" or "inspection levels".

## 9.1 Till matrix

### 9.1.1 -230 (-62.5 μm) fraction

Samples of the -230 mesh (-62.5μm) fraction from the grid till samples were submitted to Bondar Clegg Co. Ltd. in Ottawa Ontario for analysis. Approximately 0.5 gm was digested in a 1:3 ($HCL$-$HNO_3$) Aqua Regia solution. The resulting solutions were analysed by the Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) technique for a suite of 38 elements. These elements include all of the elements, except B, that are enriched in the ore zone, as discussed in the above section on lithogeochemistry.

Analytical results for the 58 till samples are given in Table 4a of Appendix A. Data is presented for 17 trace elements (Li, Sc, V, Cr, Co, Ni, Cu, Pb, Zn, As, Sr, Y, Zr, Ag, Ba, La and Ce) and 4 major elements (Al,Fe,Mn and Mg). Analytical results for standards, analytical sample splits and field duplicates are given in Tables 4b-d of Appendix A respectively. Many of the 38 analysed elements were noted to be mostly, or entirely, below detection limits and have been eliminated from Table 4a. These include Be, Ga, Nb, Sn, Sb, Te, Ta, W, Ti and Na. Other elements are below detection limits in more than 50% of the samples with very low concentrations in the remainder of the data set. These elements (Ca, K, P, Mo and Cd) do not vary systematically with underlying bedrock of proximity to the ore zone and have also been eliminated from Table 4a.

The data presented in Table 4a indicates a striking geochemical contrast between the -230 (-62.5 μm) fractions of sandstone- and rhyolite-dominated tills. The sandstone-dominated tills (i.e. most samples between #1 and #40) are significantly enriched in most trace and major elements when compared to the rhyolite-dominated tills (#41-#62). This enrichment is evident for Cu (10-38 vs <10ppm), Pb (100-6758 vs 8-111ppm), Zn (83-1026 vs 14-104ppm), Ni (15-25 vs 2-10ppm), Co (6-18 vs 1-4ppm), Fe (1.43-3.48 vs 0.30-1.15pct), Mn (<0.05-0.12 vs <0.05pct), Mg (0.21-0.62,except #36-0.12 vs <0.05-0.14pct), Li (10-34 except #36-6ppm vs 3-38ppm), V (8-27 vs 6-11ppm), Cr (6-26 vs 2-8ppm), La (9-25 vs 2-11ppm) and Ce (34-82 vs 12-33ppm). The sharp contrast in the geochemical characteristics of the "sandstone" and "rhyolite" tills indicates that the matrix was generated from comminution of the respective rock types.

The sandstone tills are also moderately enriched in As, Sc and Y compared to the rhyolite tills, however, there is substantial overlap between the two groups. Both tills have virtually the same contents of Ag, Sr and Ba although the highest values occur over the sandstone tills. Rb contents are the same in both till clast-types. The lack of distinction between sandstone- and rhyolite-dominated tills for these elements possibly represents similarities in elemental concentrations in both bedrock types.

There have been no previous till geochemical surveys for either the GHG or the LLB. However, Stea et al. (1986) presented data for tills collected over the Cumberland Basin of northern Nova Scotia. They have separated their data into two groups based on the predominance of red or grey sandstone. They then calculated the basic statistics for a suite of elements from each of the groups. Based upon the similarities in age and stratigraphy between the grey sandstones of both the Cumberland Basin and GHG we have used the data of Stea et al. (1986) to set "inspection levels" or "thresholds" for Cu, Pb, Zn, Ni, Co, Fe, Mn, Mg and As. Once again we caution the reader that these "levels" are merely guides for evaluation of the data and do not represent rigorous statistically-derived values.

There are vast differences in the values of both Pb and Zn between the tills over the Silvermine Formation along the northern part of the grid and near the subcrop of the ore zone. In fact values of Pb (1->10T) occur in a 750-1000m wide band that cross-cuts the entire sample grid (Fig. 16a). Elevated Zn values (1->3T) are restricted to the same zone of Pb enrichment (Fig. 16b). Highest values of Pb and Zn occur directly over the subcrop of the east zone ore horizon and extend to the northeast, over the top of the adjoining drumlin (Fig. 9). Lithogeochemical analyses indicate high levels of Mn in the ore body. Several anomalous values of Mn (>0.19 pct) occur sporadically through the rhyolite/sandstone contact zone and near the ore zone which may reflect bedrock enrichment. It is also possible that a part of this Mn enrichment may be due to surficial hydromorphic processes. Similarly elevated values of As (>27 ppm) were noted in 5 samples from the zone with anomalous Pb and Zn and may reflect minor enrichment in the bedrock source(s). Only two anomalous Ag values (>0.5ppm) were noted. Both samples were collected near the northern part of the grid, approximately 1 km from the subcrop of the east zone. The lack of Ag enrichment presumably reflects the low concentrations in the ore body (<10ppm). There are no "anomalous" values of Cu (Fig. 16c), Ni, Co, Fe or Mg in the analytical data for the -230 (-62.5 $\mu$m) fraction when compared to the data of Stea et al. (1986). However, Cu is enriched over the ore zone.

The lithogeochemical data indicates that the ore body is enriched in several elements that are tied up in heavy minerals (e.g. Zr, Ba). A contoured plot of Zr, which predominantly resides in the mineral phase zircon, is presented in Fig. 16d. There is little apparent correlation between Zr concentration and the east ore zone. Similarly the concentration of Ba does not reflect the location of the ore zone (Fig. 16e). On the contrary, the highest Ba contents are located northward into the basin from the ore zone. The exact significance of thehigh Ba values is not clear, however, they may be the result of barite mineralization and merit future investigation.

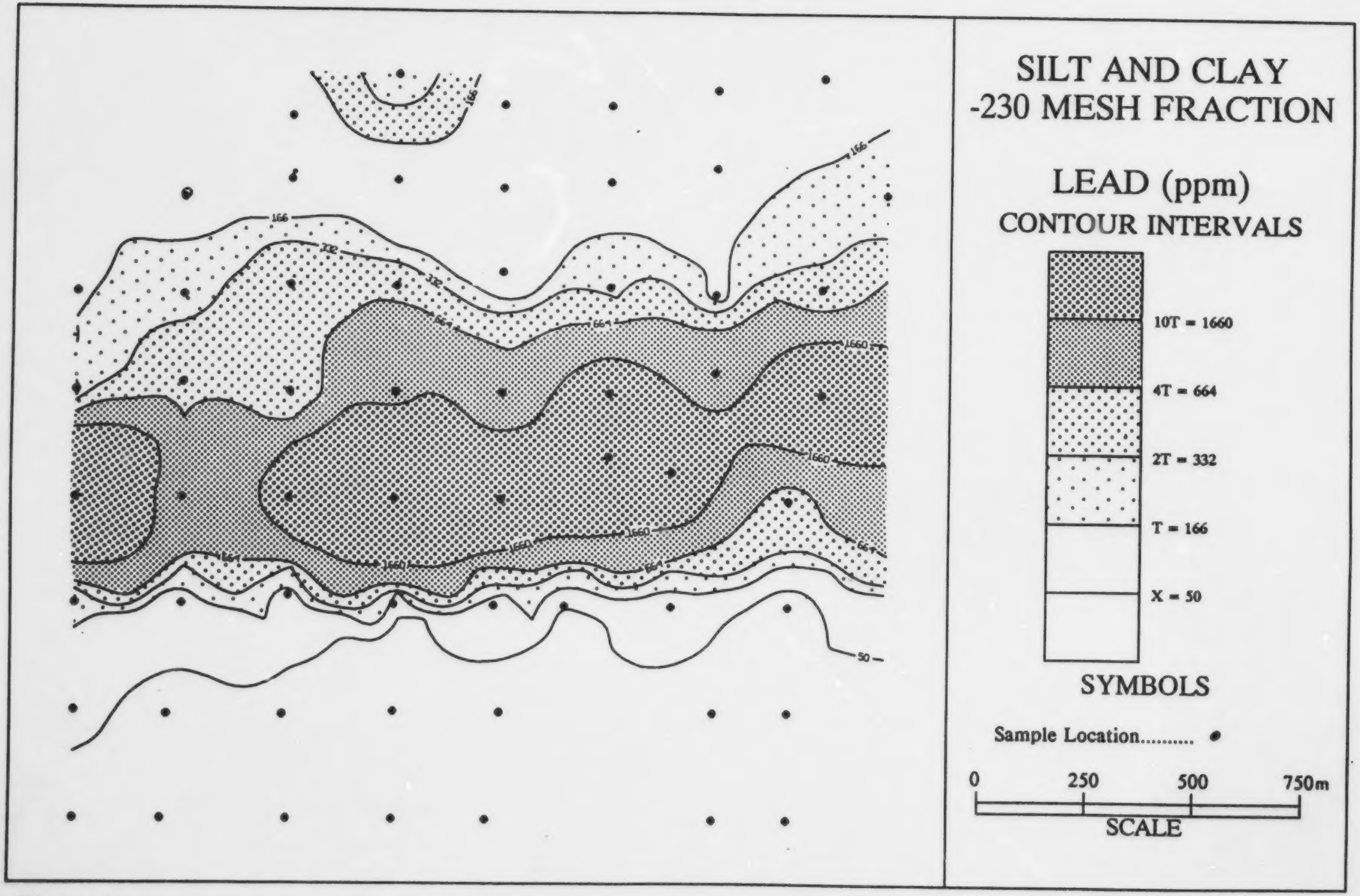

SILT AND CLAY
-230 MESH FRACTION
LEAD (ppm)
CONTOUR INTERVALS
10T = 1660
4T = 664
2T = 332
T = 166
X = 50
SYMBOLS
Sample Location..........
0
250
500
750m
SCALE
166
332
664
1660
50

Figure 16a

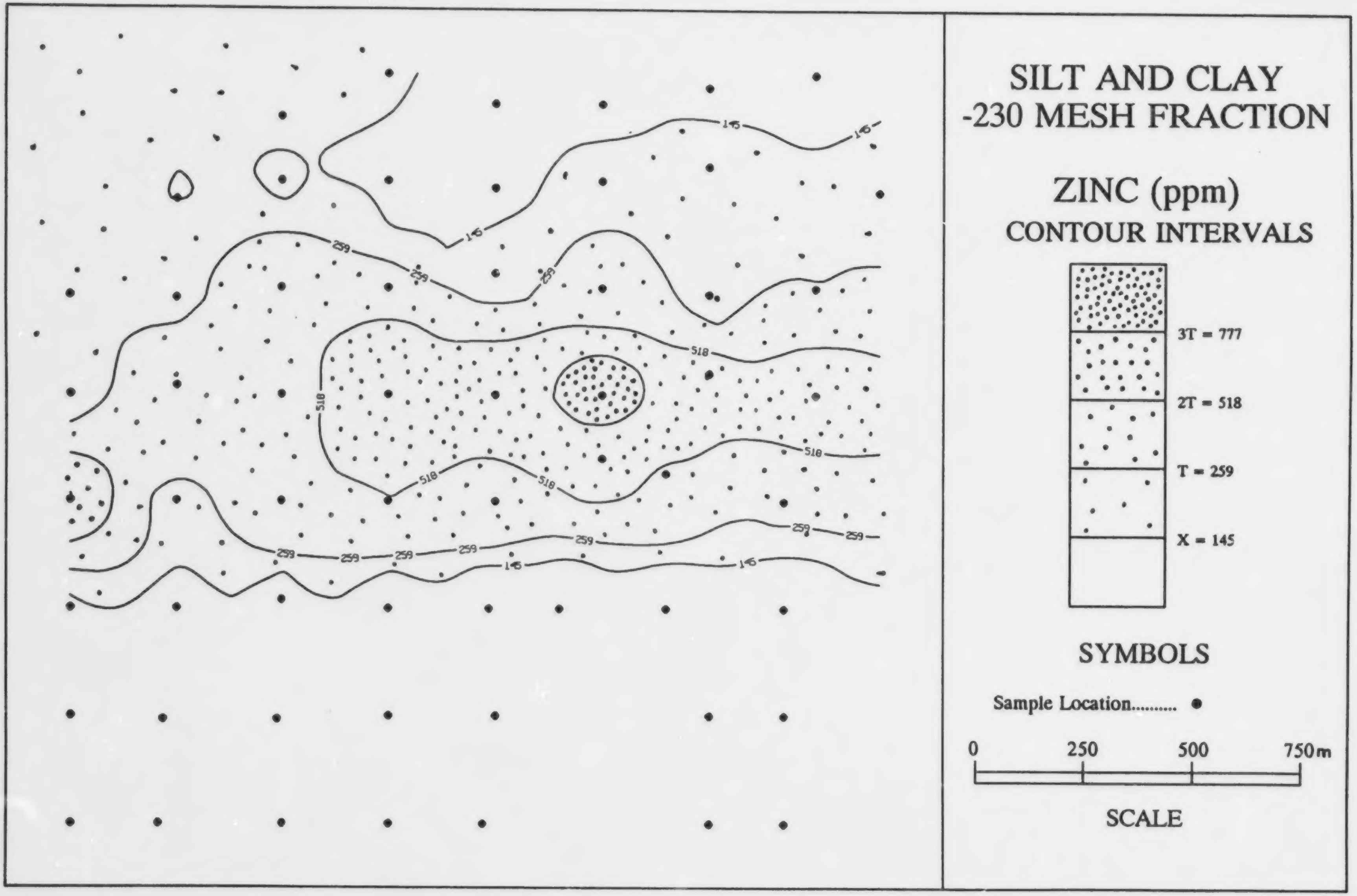

SILT AND CLAY
-230 MESH FRACTION
ZINC (ppm)
CONTOUR INTERVALS
3T = 777
2T = 518
T = 259
X = 145
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
145
259
518

Figure 16b

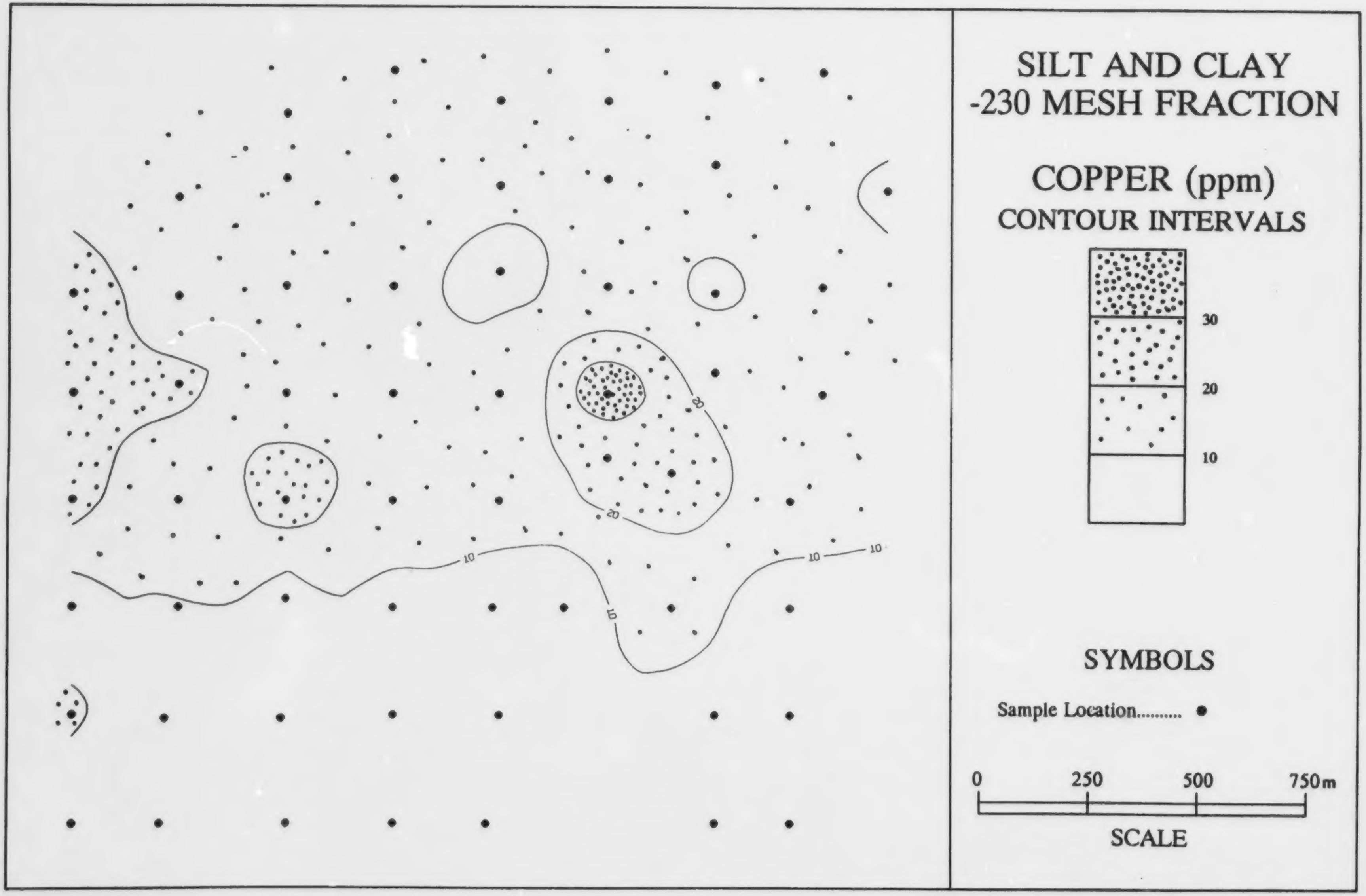

SILT AND CLAY
-230 MESH FRACTION
COPPER (ppm)
CONTOUR INTERVALS
30
20
10
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
10
20

Figure 16c

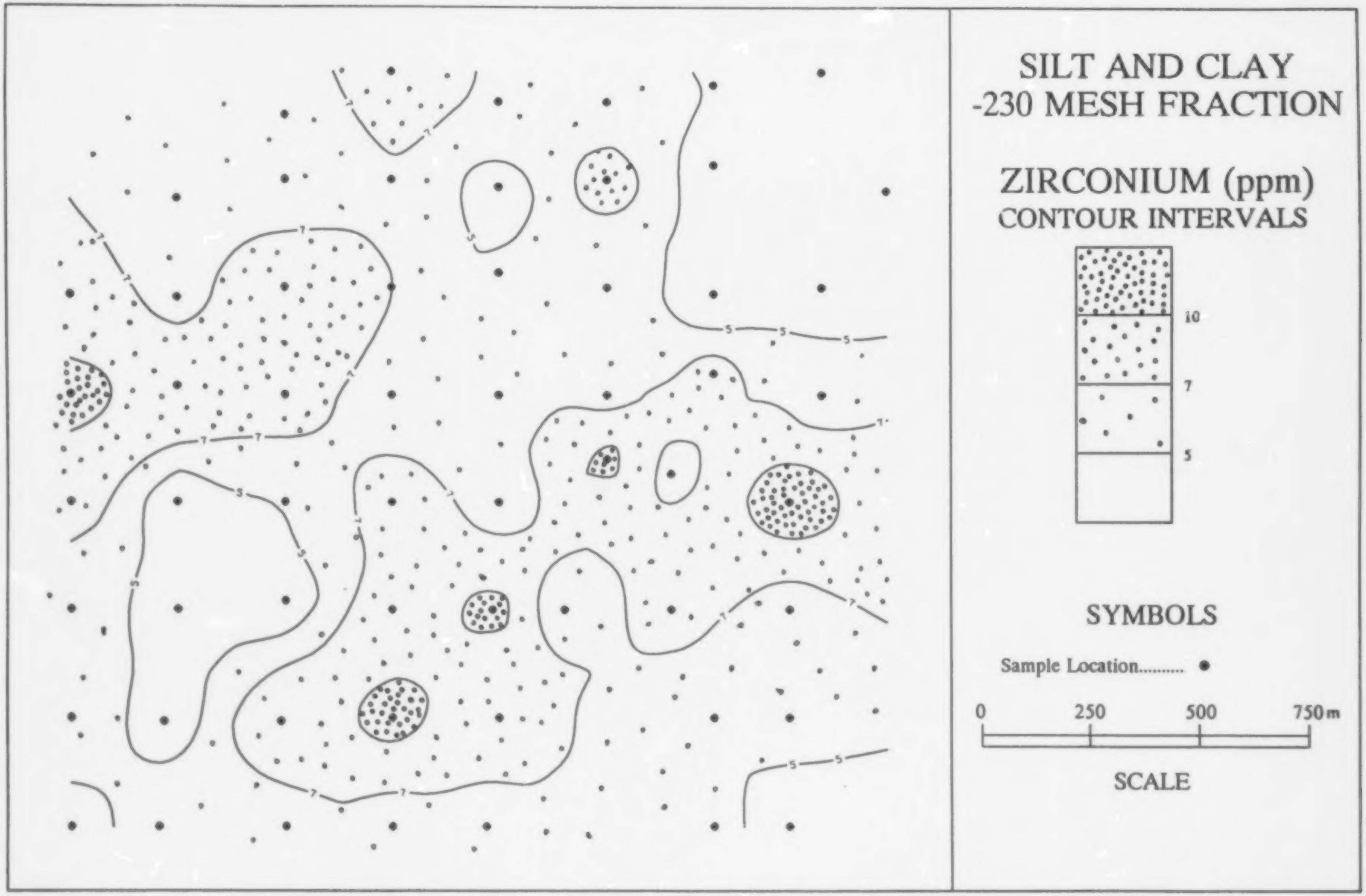

SILT AND CLAY
-230 MESH FRACTION
ZIRCONIUM (ppm)
CONTOUR INTERVALS
10
7
5
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
5
7

Figure 16d

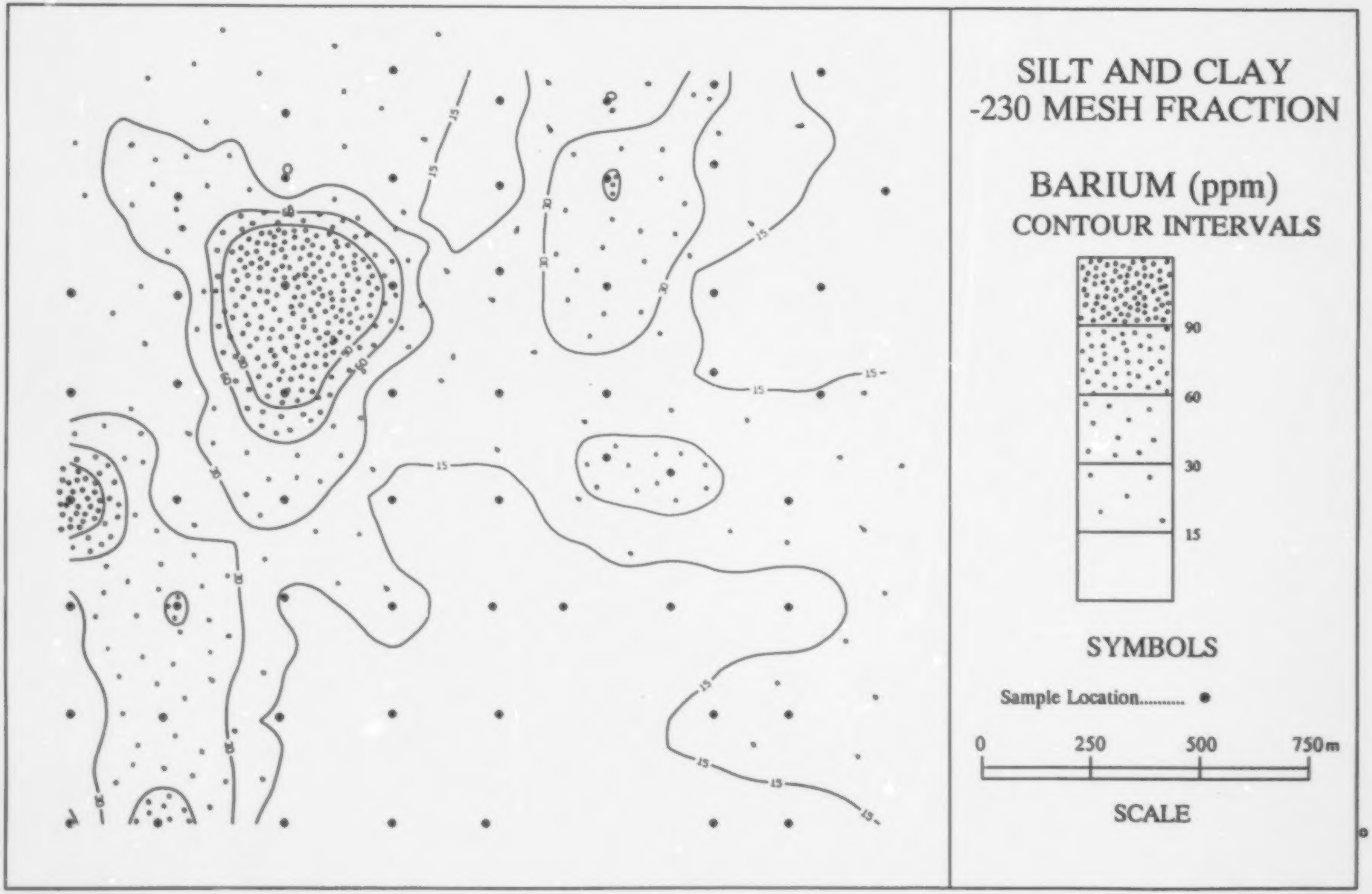

SILT AND CLAY
-230 MESH FRACTION
BARIUM (ppm)
CONTOUR INTERVALS
90
60
30
15
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
15
30
60
90

Figure 16e

Several points can be made regarding the analytical data of the -230 mesh (-62.5μm) till fraction. Firstly, there is a well developed ribbon-shaped anomaly for both Pb and Zn that is most pronounced over the east zone ore subcrop and extends both up- and down-ice from it. A till survey should have a spacing of approximately 750-1000m in order to locate other possible Yava-type deposits. Our data does not follow the low topographic areas as did the data of Geisler (1963). Therefore by sampling only material from below the oxidized zone we have apparently avoided the hydromorphic effects that dominated Geisler's (1963) results. Elevated concentrations of Pb and Zn in the surface ground moraine extend over the drumlin on the eastern part of the sample grid. As stated above, our overburden drilling indicates that this drumlin is cored by a highly-compacted clay-rich till that presumably was deposited by northeast ice flow. The high values of Pb and Zn in the overlying till may reflect down-ice dispersion over the clay-rich drumlin core or conversely it may arise from reworking of underlying till that contained high Pb concentrations. This will be further discussed in Section 10.

### 9.1.2 Heavy minerals from -60+230 (-250+62.5 μm) fraction

The non-magnetic portion of the -60+230 mesh (-250+62.5 μm) heavy mineral separates from the grid samples were sent to Chemex Laboratories Ltd. of North Vancouver, British Columbia for analysis. Approximately 0.5 gm of sample were digested in a mixture of nitric-perchloric-hydrofluoric-hydrochloric acids and analysed for a suite of 25 major and trace elements (Ag, Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sr, Ti, V, W, Zn and Zr) by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). The standard upper limit for most trace elements by this technique is 10 000 ppm. All samples that contained trace element concentrations in excess of this upper limit were subsequently re-diluted and reanalysed to obtain precise concentrations.

As noted above, the Yava ore zones contain significantly more heavy minerals than do the unmineralized Silver Mine Formation. Tills derived from these ore zones should also be enriched in heavy minerals. Sangster and Vaillancourt (1990) noted the presence of zircon, rutile and barite in the Yava deposit. Rutile and ilmenite are mostly insoluble in the above multi-acid digestion and therefore Ti values will be low by this technique. Conversely, barite is very soluble in the multi-acid digestion but tends to complex with Cl (from dissociated HCl) to form insoluble BaCl that will precipitate from solution prior to analysis. Therefore, Ba values may also be low when the standard multi-acid digestion is employed. To evaluate these effects, approximately 0.2 gm of the heavy mineral concentrates were mixed with a lithium-metaborate flux and fused in platinum crucibles over a bunsen burner. The resulting glass beads were then digested in nitric acid and analysed by the same ICP-AES procedure. As predicted, there were substantial increases in Ba and Ti. Analytical results for the two techniques have been plotted for both Ba and Ti and are presented in Figs 17a and b. The maximum value of Ba by the multi-acid digestion was 215 ppm whereas concentrations of 281 000 ppm were encountered in samples prepared by the fusion technique. In fact, many acid-digestion values were between 0.1% to 25% of the fusion results. The highest Ba values (>10 000) were for samples collected from the lower 2a till sheet in a section at the entrance to the west zone decline. These have been included in Figs 17a and b to display the maximum contrast between the two sample preparation techniques. Titanium values were consistently lower by the acid digestion technique but were mostly between 35% to 90% of the fusion data (Fig. 17b). The acid-digestion data for Al, Ca, Fe, Mg, Mn and Na were mostly 80% to 100% of the fusion data. In light of these results the analyses from the Li-metaborate fusion have been substituted for the initial Al, Ba, Ca, Fe, Mg, Mn, Na, Ti and Zr values whereas the remainder of the elements were determined by the above multi-acid digestion. Analytical results (unweighted) are given in Table 5a of Appendix A. Several samples did not have sufficient sample for the Li-metaborate fusion. These samples will have i.s. (insufficient sample) for the appropriate elements in Table 5a. Virtually all samples had concentrations of Be, Bi and W that were below detection limits (0.5, 2 and 10 ppm respectively) and accordingly these elements have been omitted from Table 5a.

The raw analytical data was weighted according to the method of Toverud (1982) using the formula El(W) = El(R) x (W1/W2), where El(W) is the weighted element value, El(R) is the

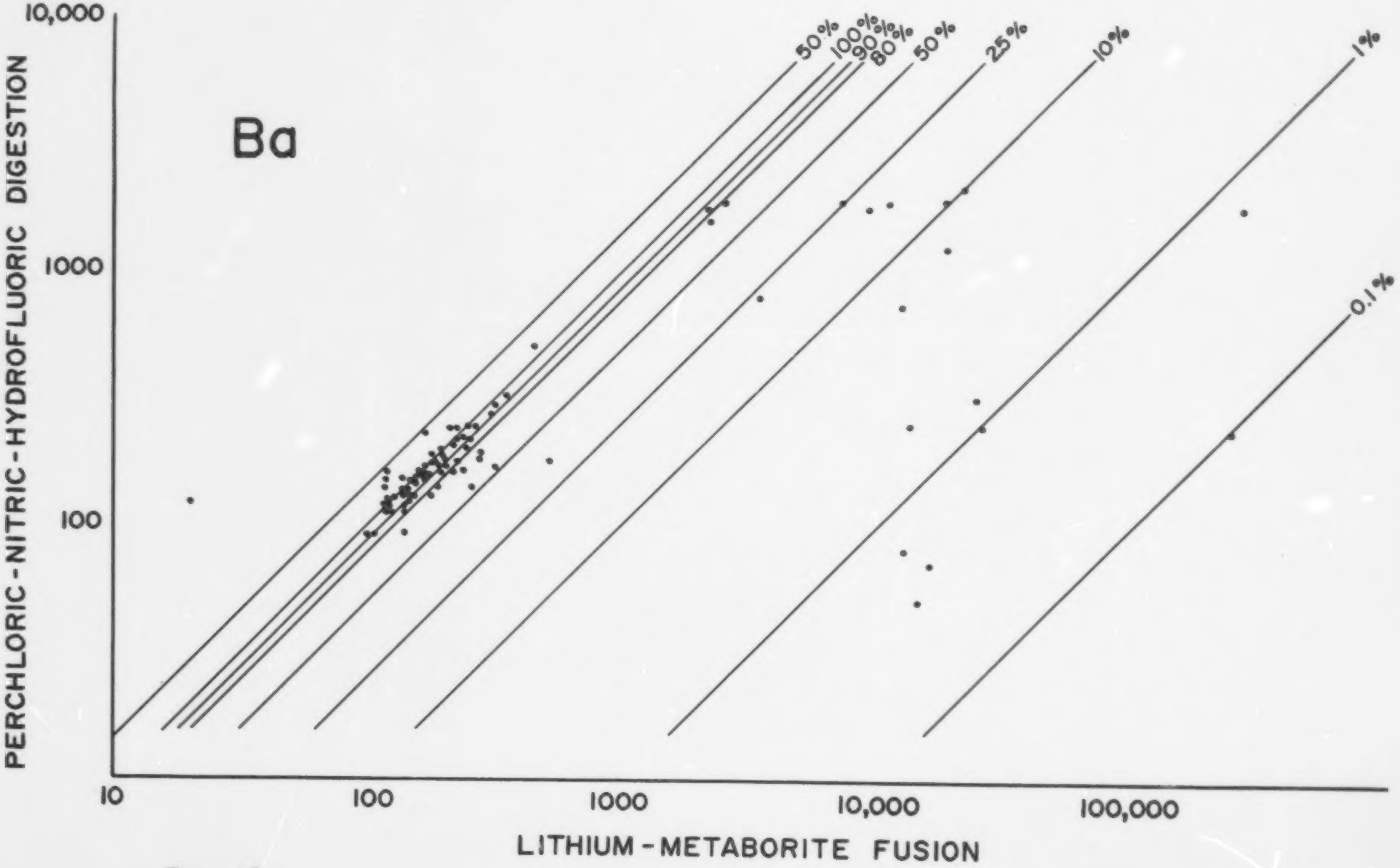

Ba
PERCHLORIC-NITRIC-HYDROFLUORIC DIGESTION
10,000
1000
100
10
100
1000
10,000
100,000
LITHIUM-METABORITE FUSION
50%
100%
90%
80%
50%
25%
10%
1%
0.1%

Figure 17a

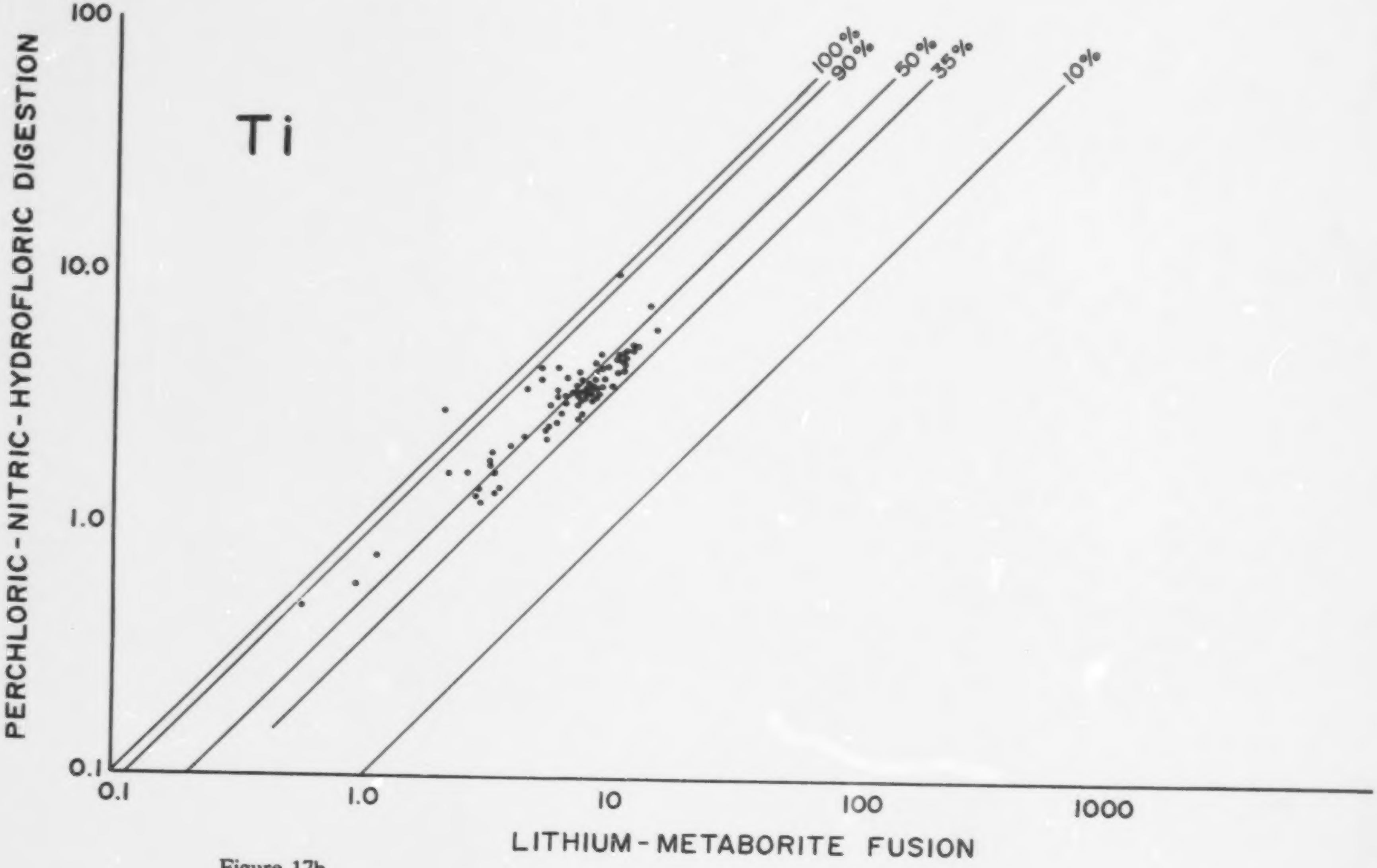

Ti
PERCHLORIC-NITRIC-HYDROFLORIC DIGESTION
100
10.0
1.0
0.1
0.1
1.0
10
100
1000
LITHIUM-METABORITE FUSION
100%
90%
50%
35%
10%

Figure 17b

raw analytical value for that element, W1 is the heavy mineral concentrate extracted from a measured weight (W2) of the -60+230 mesh (-250+62.5 μm) till matrix. The weighted values are given in Table 5b of Appendix A. Unweighted analytical data is given for the standards in Table 5c. Unweighted and weighted data for the analytical sample splits and field duplicates are given in Tables 5d to 5g of Appendix A.

Initial investigation of the data indicates that the pronounced differences between sandstone- and rhyolite-dominated tills that were evident in the -230 mesh (-62.5μm) till matrix are much less apparent in the weighted heavy mineral data set. For example the ranges of Cu concentrations in the weighted heavy mineral data are 0.0005 - 1.2472 for the sandstone-dominated tills and 0.0036 - 0.2269 for the rhyolite-dominated tills. This contrasts with 10-39 and <10 ppm respectively in the -230 mesh (-62.5μm) fraction. Similar results were obtained for most of the other elements in Table 5b.

There is no regional heavy mineral till data available for the study area, or in fact for Cape Breton Island. Therefore, it was not possible to set inspection levels or thresholds for contouring purposes. Consequently, we have ranked the data and selected intervals as outlined at the beginning of this section. Contour plots for 10 elements are presented in Figs. 18a to j. The plots include a)Pb; b)Zn; c)Cd; d)Ag; e)Cr; f)Cu; g)Zr; h)Sr; i)Ba; and j)Ti.

Several interesting points can be made from the contoured data. Firstly, Pb, Zn and Cd (Figs. 18a to 18c) clearly define a ribbon-shaped enriched zone that coincides with the subcrop of the East Zone ore body and extends over the adjacent drumlin to the northeast. The enrichment pattern is very similar in size and orientation to that of the -230 mesh (-62.5μm) till fraction discussed previously. Also there are pronounced decreases in the concentrations of Pb,Zn and Cd along the sandstone/rhyolite contact. In contrast, high values extend northward over the unmineralized(?) Silver Mine Formation. A second group of elements distinguishes between the sandstone- and rhyolite-dominated tills, although, as discussed above, not to the extent of the -230 mesh (-62.5μm) data. These elements include Ag, Cr, Cu, Zr and Sr (Figs. 18d to h). Several very high values were noted for these elements. Two samples (#32 and #23) are enriched in Ag, Cr, Cu and Zr and may reflect localized enrichment associated with the East Zone mineralization. It should be noted that sample #23 occurs near the apex of the large drumlin and therefore does not represent a direct bedrock source. Sample #61 overlies the rhyolite basement rocks and shows substantial enrichment in Cr and Sr. The exact source of this enrichment is unclear. Concentrations of both Cr and Zr are enriched in a band (approx 250 x 1000m) that parallels, but occurs 0.5-0.75 north of the deposit. These patterns may reflect heavy mineral-rich channel sands stratigraphicly above the deposit, but further work is required to determine this unequivocally. The final suite of elements includes Ba and Ti (Figs. 18i and j). Both elemental plots display peculiar patterns. There is no apparent correlation between concentration and rock type and in fact the "trends" are perpendicular to the major rock contacts. Also, with the exception of sample #32, there is no apparent correlation to the ore zone. The lack of correlation of many elements that are enriched in heavy mineral suite (e.g. Ba, Zr, Ti) with the deposit subcrop. This is consistent with the results of the -230 mesh (-

62.5$\mu$m) till data and contrasts the predicted increase that should accompany the mineralized heavy mineral-rich channel sandstones described by Sangster and Vaillancourt (1990).

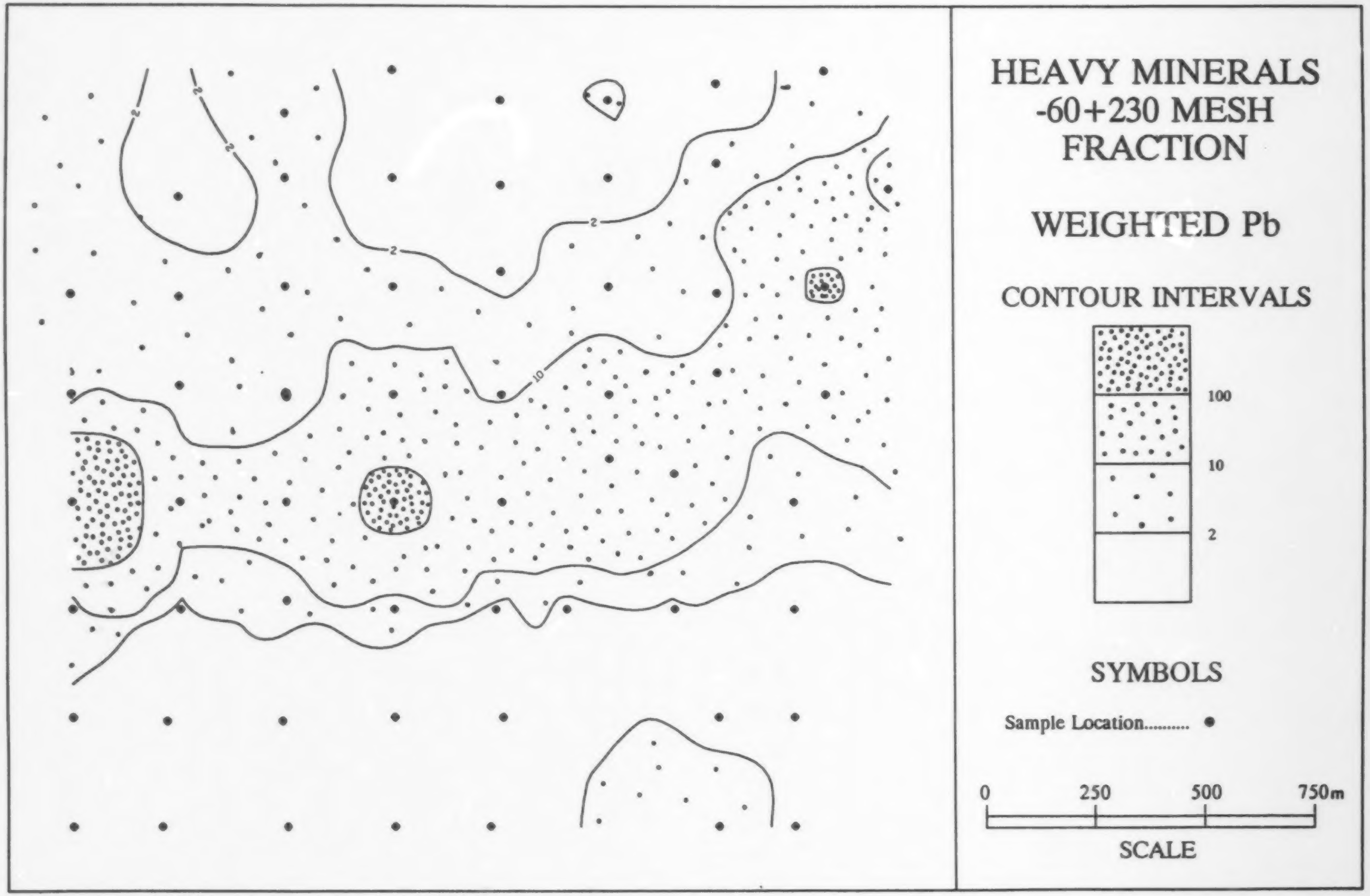

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Pb
CONTOUR INTERVALS
100
10
2
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
2
2
2
2
2
10

Figure 18a

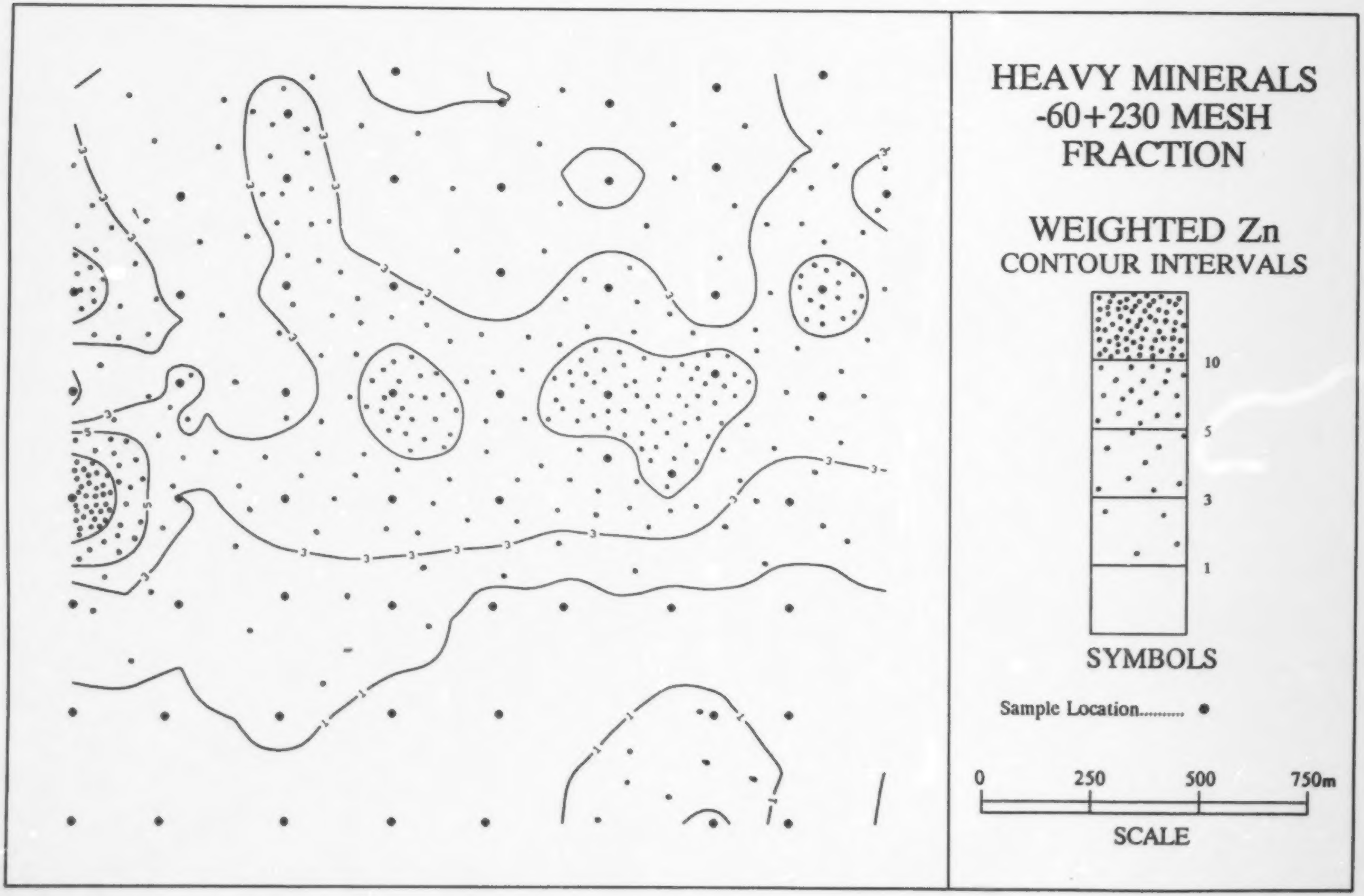

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Zn
CONTOUR INTERVALS
10
5
3
1
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
3
5
1

Figure 18b

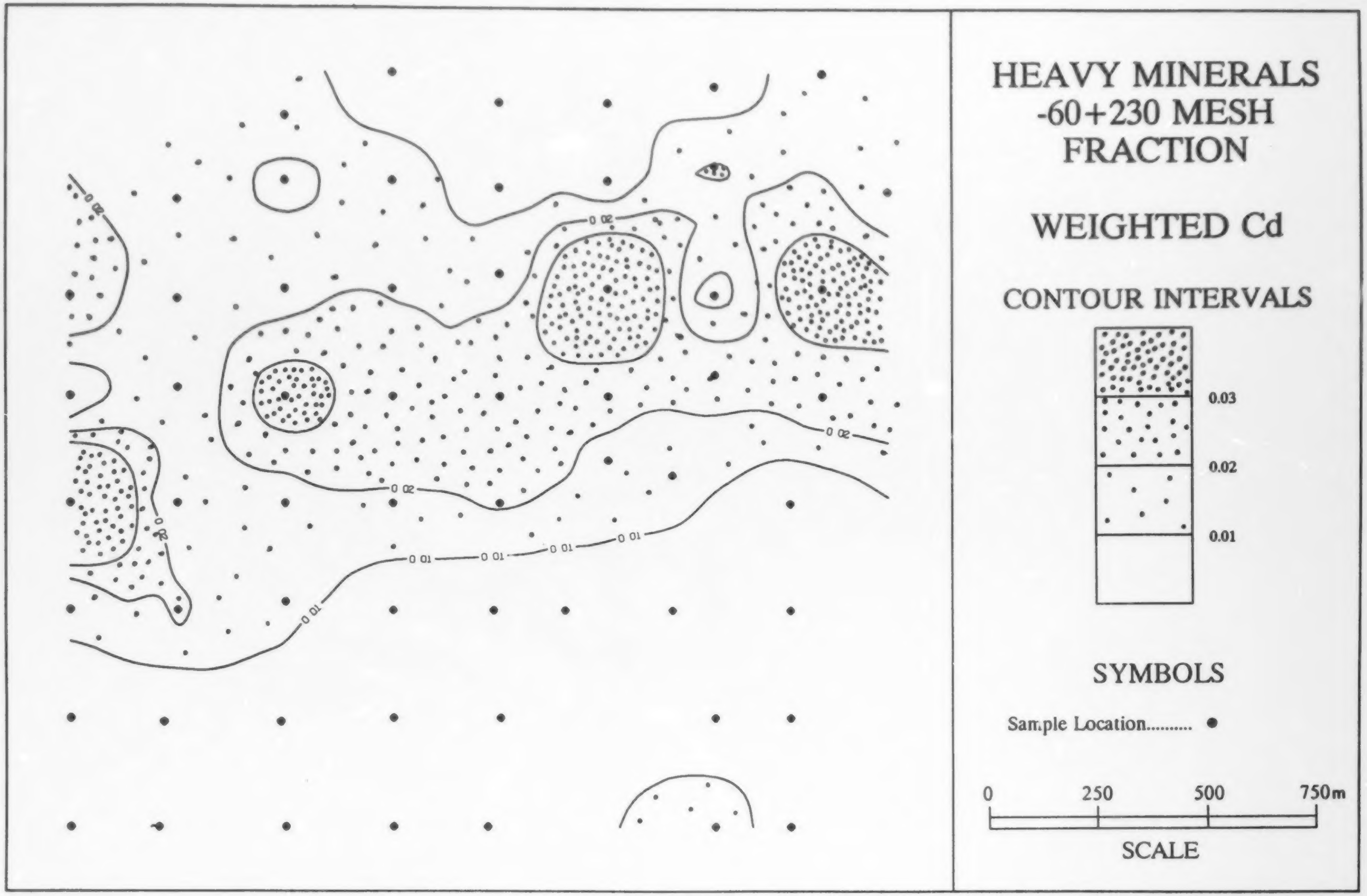

0.02
0.02
0.02
0.02
0.02
0.01
0.01
0.01
0.01
0.01
HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Cd
CONTOUR INTERVALS
0.03
0.02
0.01
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE

Figure 18c

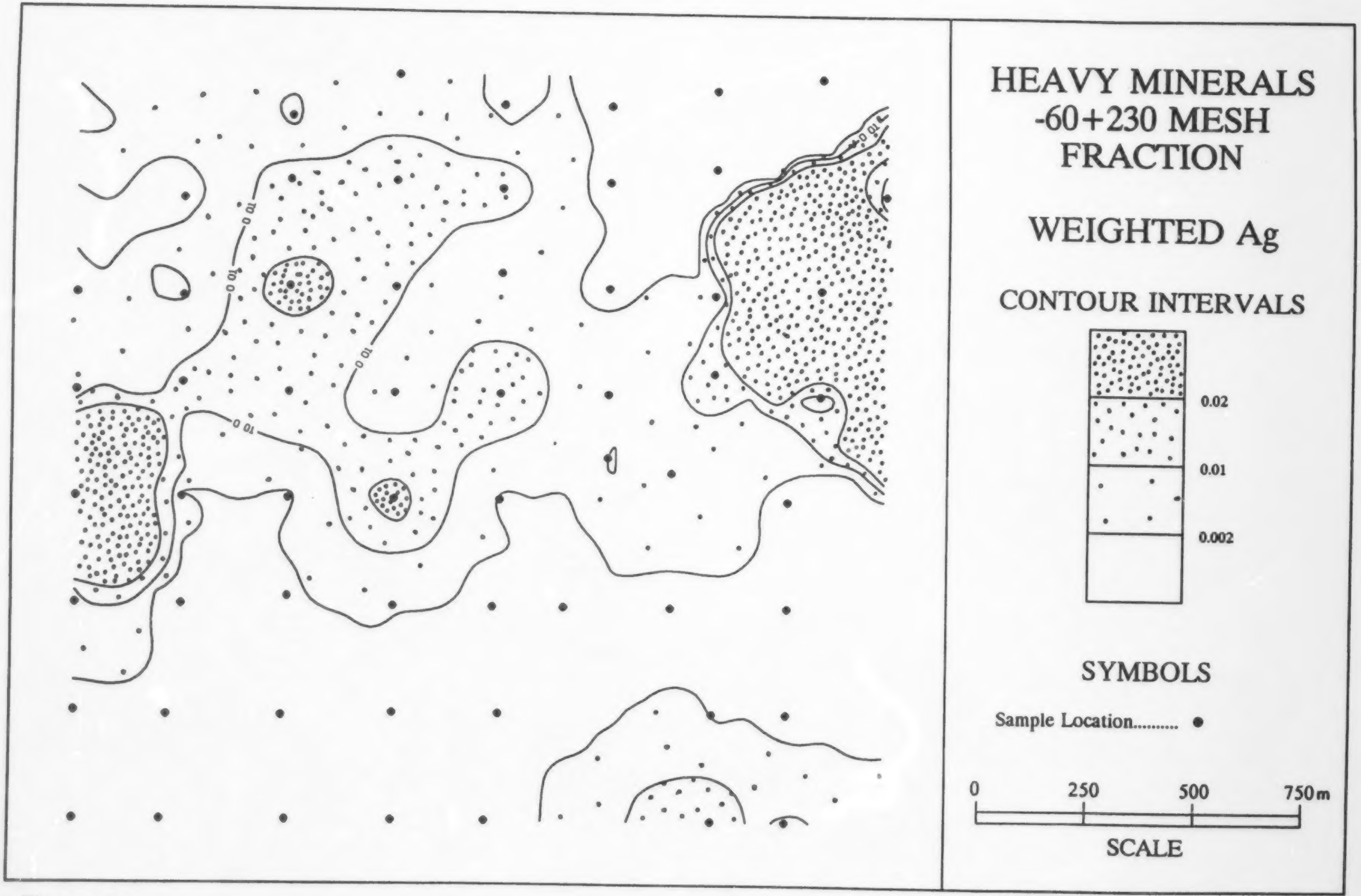

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Ag
CONTOUR INTERVALS
0.02
0.01
0.002
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
0.01
0.01
0.01
0.01
0.01
0.01

Figure 18d

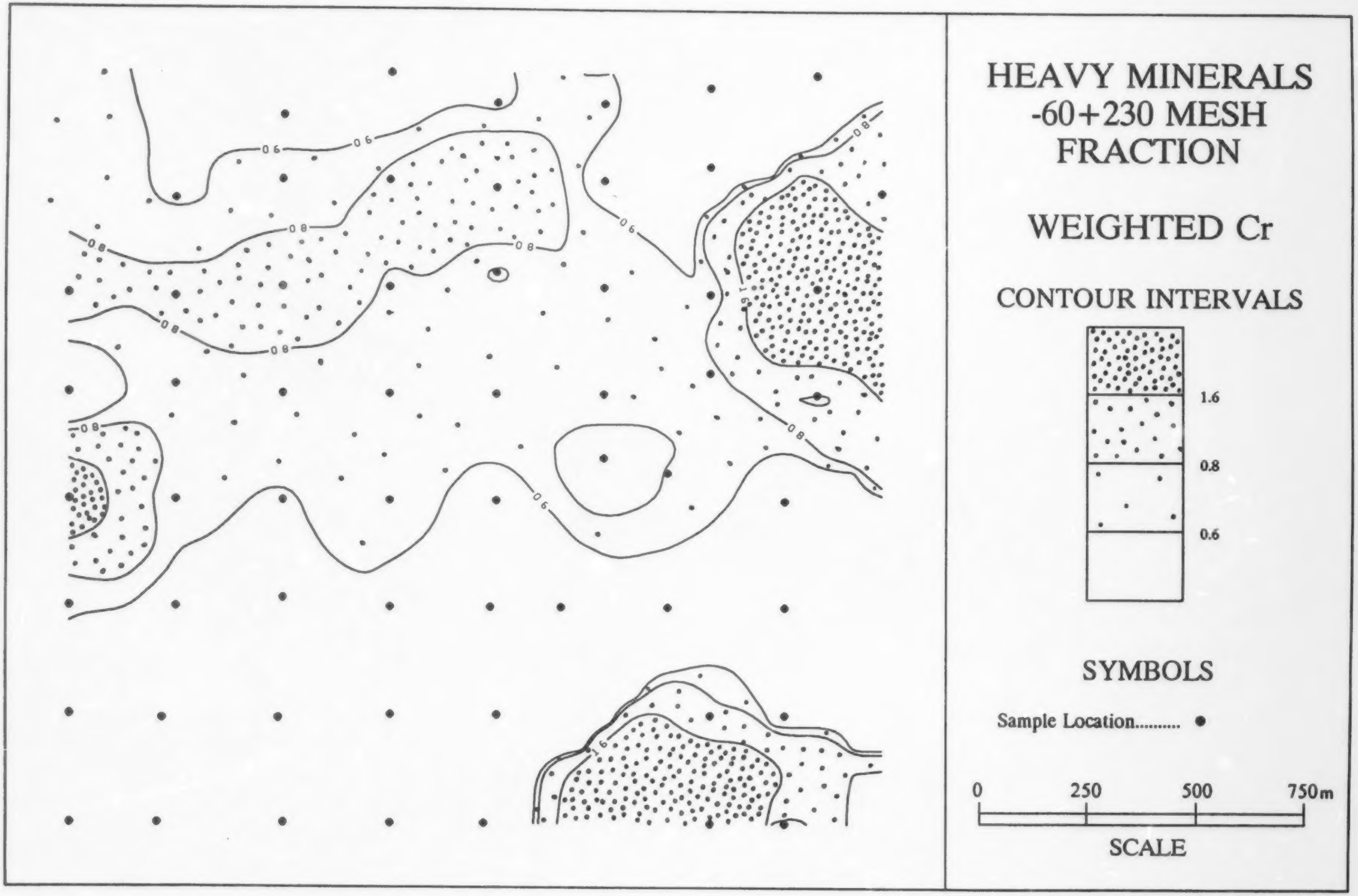

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Cr
CONTOUR INTERVALS
1.6
0.8
0.6
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
0.6
0.8
1.6

Figure 18e

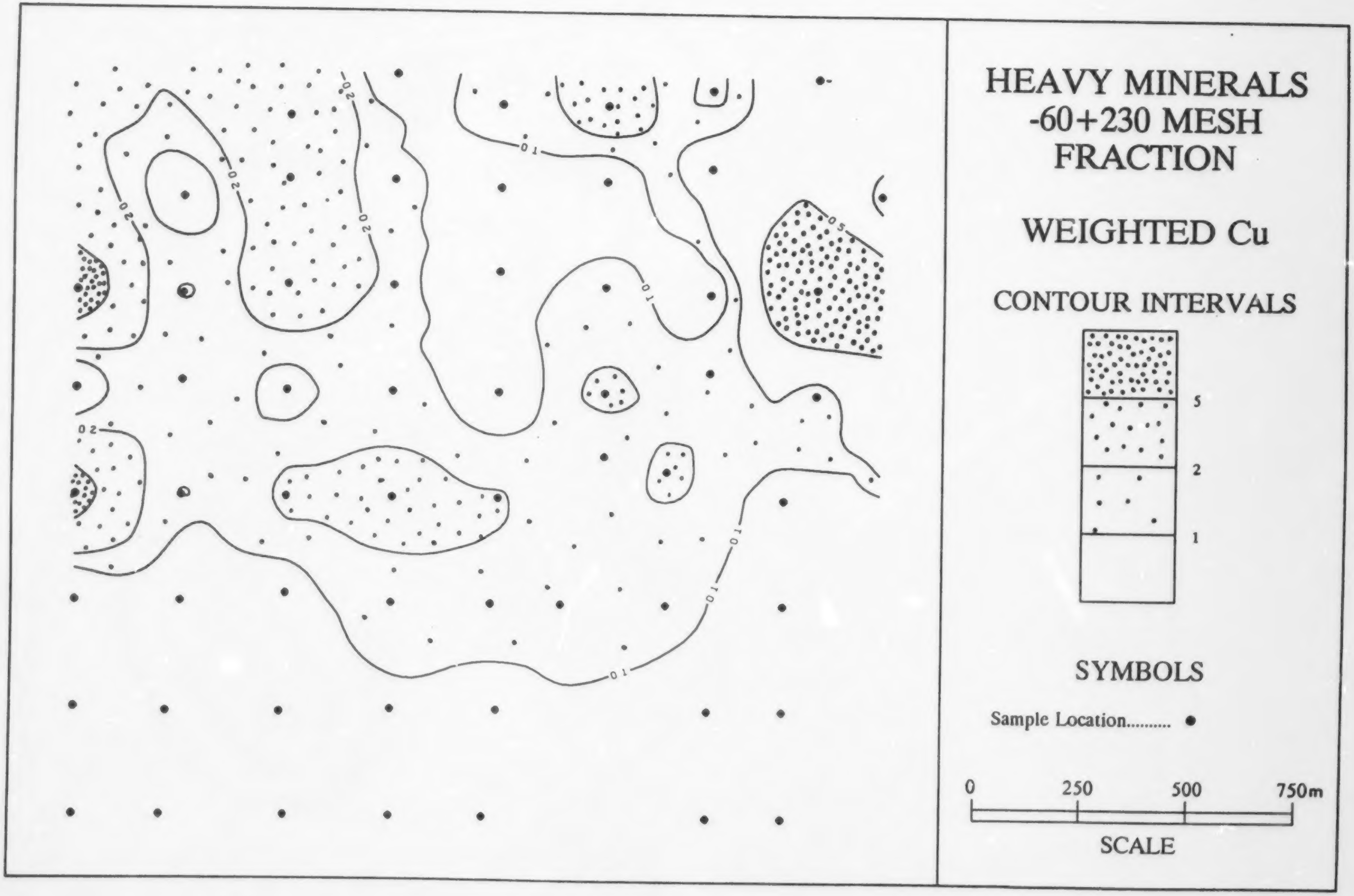
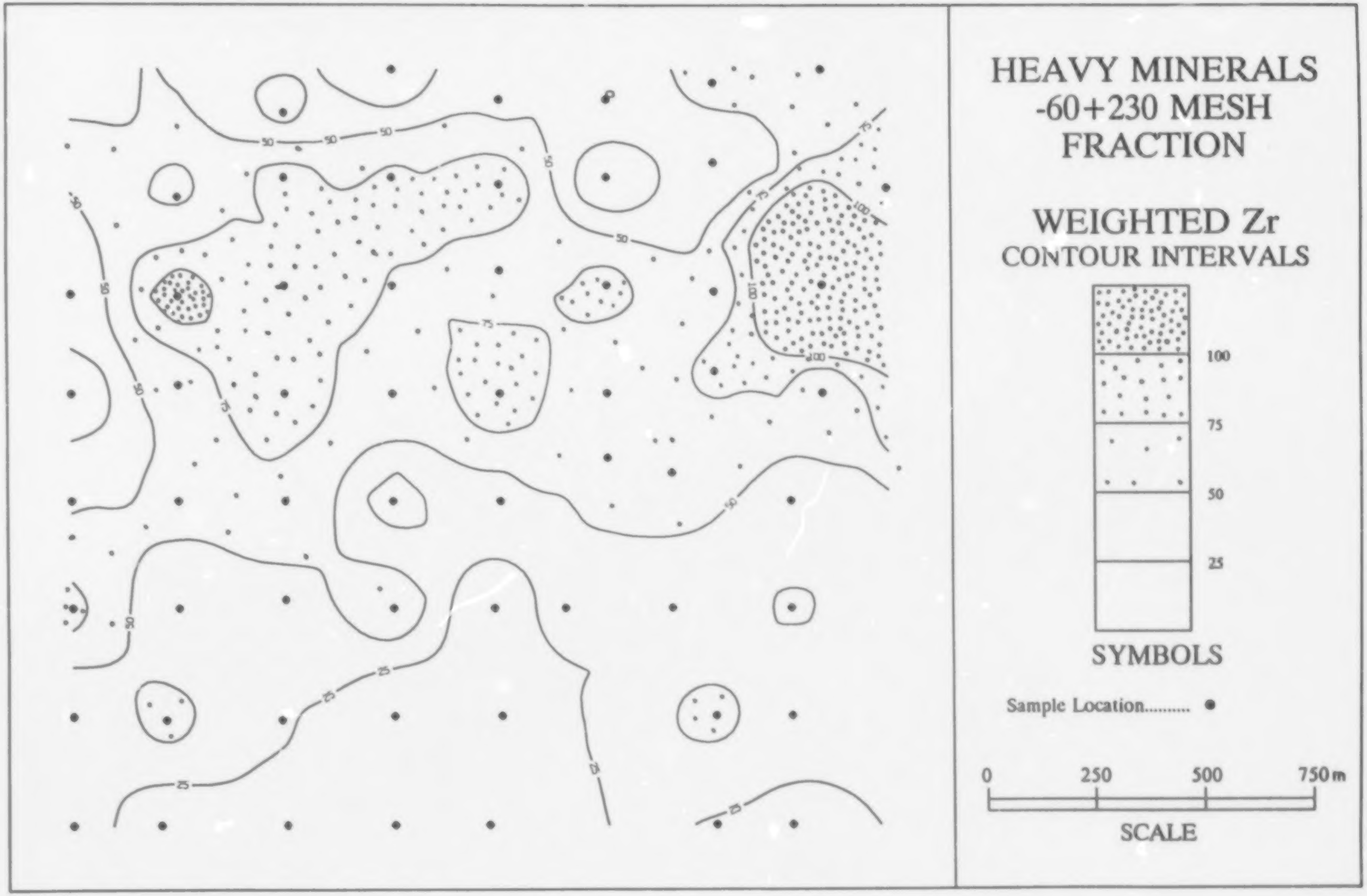

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Cu
CONTOUR INTERVALS
5
2
1
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
0.2
0.1
0.5

Figure 18f



HEAVY MINERALS
-60+230 MESH
FRACTION

WEIGHTED Zr
CONTOUR INTERVALS

100
75
50
25
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
25
50
75
100

Figure 18g

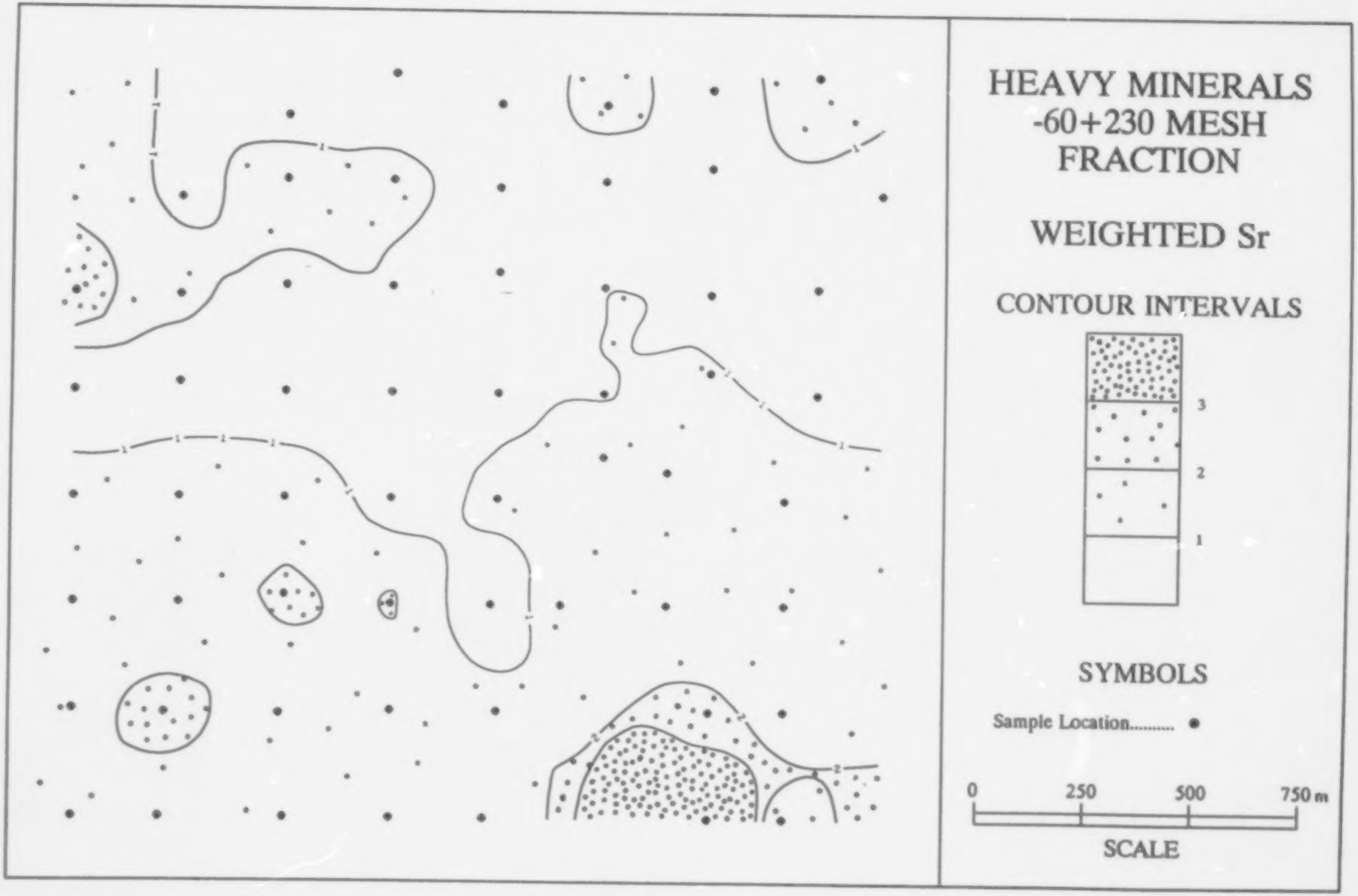

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Sr
CONTOUR INTERVALS
3
2
1
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
1
2

Figure 18h

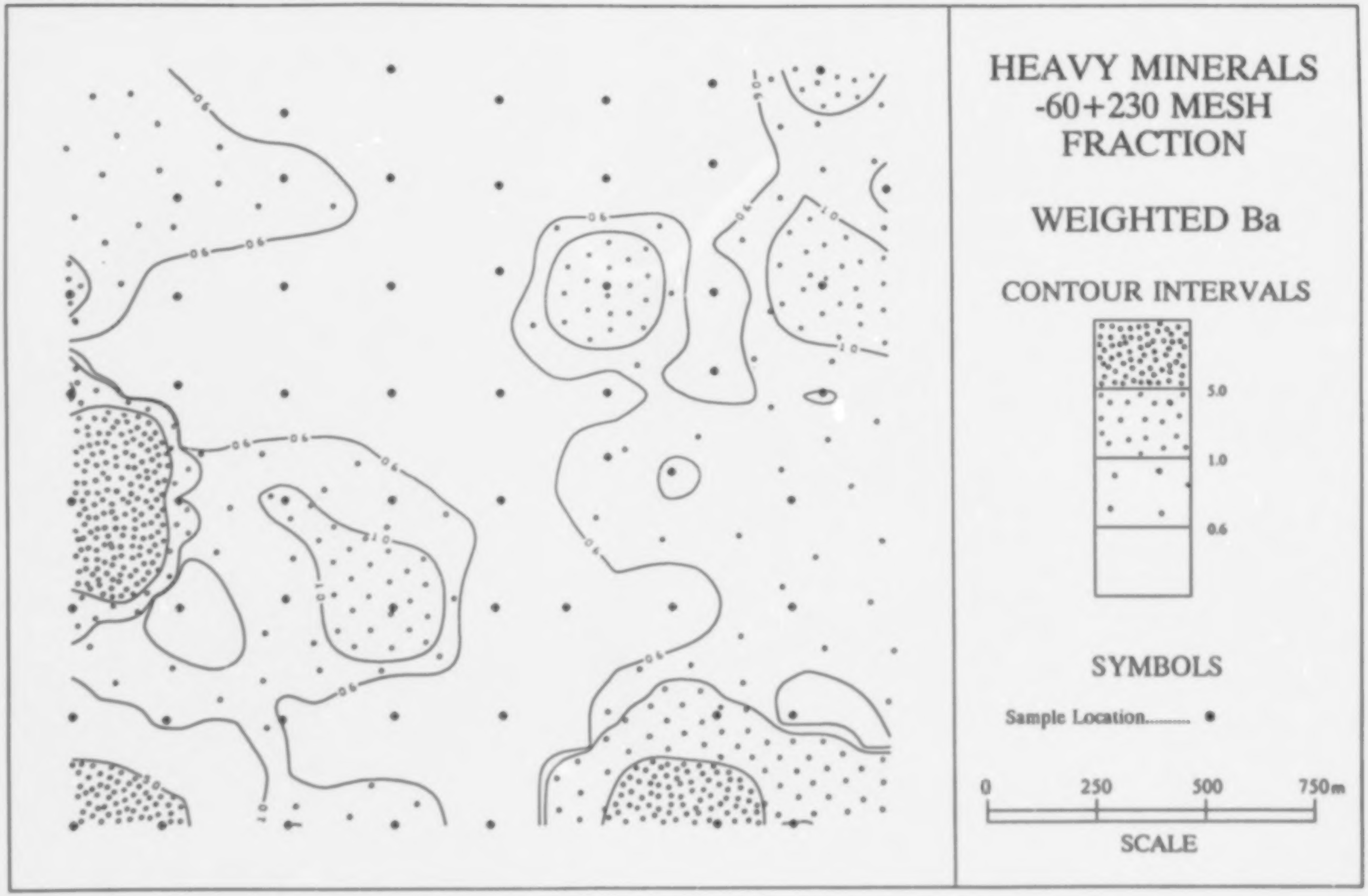

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Ba
CONTOUR INTERVALS
5.0
1.0
0.6
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
0.6
1.0
5.0

Figure 18i

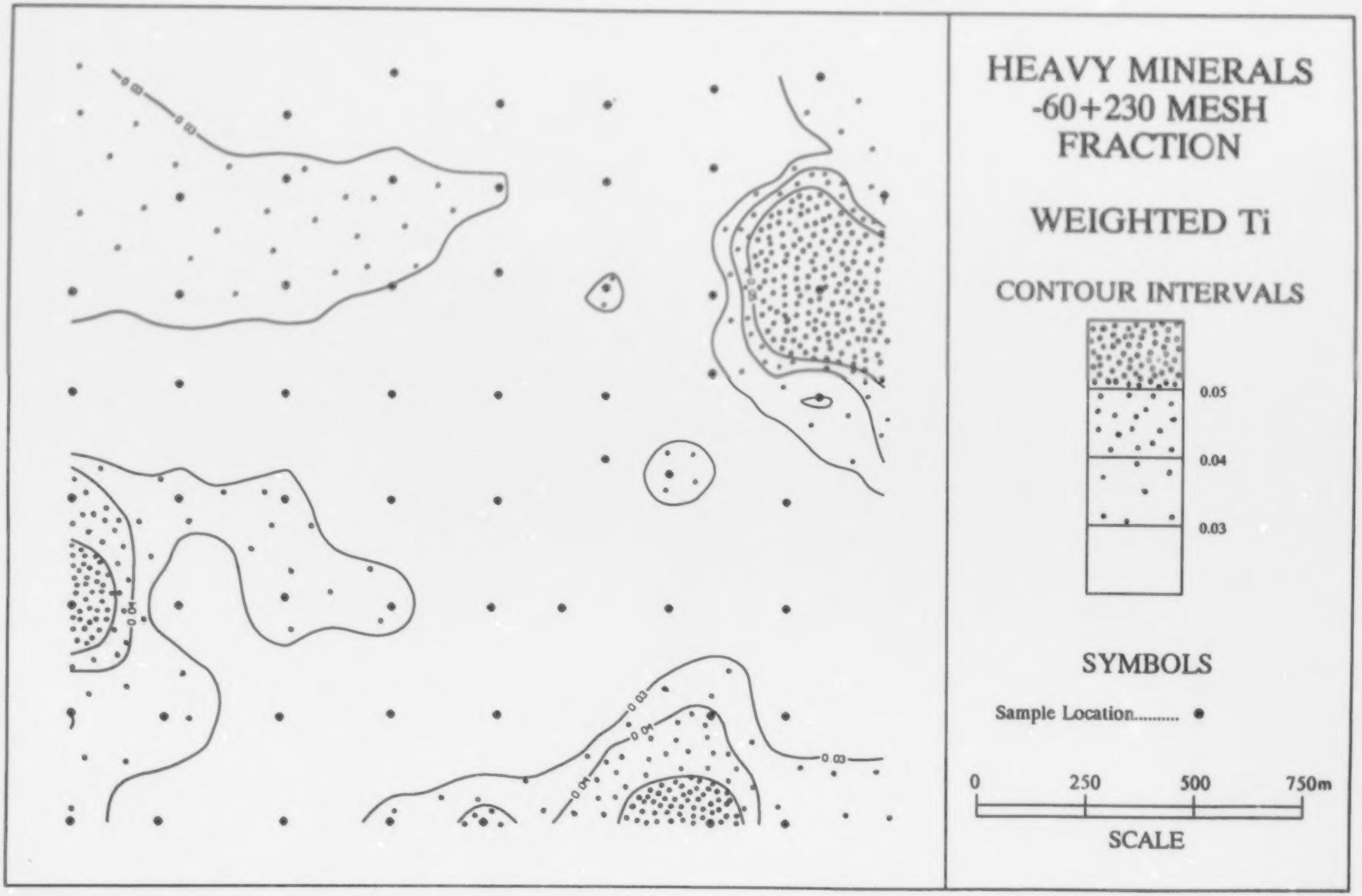

HEAVY MINERALS
-60+230 MESH
FRACTION
WEIGHTED Ti
CONTOUR INTERVALS
0.05
0.04
0.03
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
0.03
0.04

Figure 18j

## 9.2 Biogeochemistry

The ashed Balsam Fir samples were sent to ACME Analytical Laboratories Ltd. of Vancouver, British Columbia for analysis. The sample digestion and analytical procedures were the same as those of Dunn et al. (1989). Approximately 0.25-0.50 gms of ash were digested in hot $HCl$-$HNO_3$-$H_2O$ for 1 hour and then diluted with 10 ml $H_2O$. This extraction is partial for Mn, Fe, Sr, Ca, P, La, Cr, Mg, Ba, Ti, B, W and limited for Na,K and Al. The samples were then analysed for a suite of 30 trace elements by ICP-AES. Results for Mo, Au, La and W were entirely below detection limits (1, 3, 2 and 1 ppm respectively) and were disregarded. Most Bi values ranged from 2-5 ppm and were also not reported because of poor precision below 5 ppm (Dunn pers com. 1991). The analytical results for the remaining 24 elements (Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, U, Th, Sr, Cd, Sb, V, Ca, P, Cr, Mg, Ba, B, Al, Na, K) are given in Table 6a of Appendix A. As noted in the previous section, Ba will precipitate as insoluble BaCl in the presence of HCl. Therefore, Ba values are possibly lower than true concentrations.

Analytical results for the standards and analytical sample splits are given in Tables 6b - 6d of Appendix A. The data for the 6 standard analyses and 5 analytical pairs for Pb, Zn, Fe, Cu, Cd, Sb, As and P have been plotted in Fig. 19. The precision varies depending upon the element. However, in general the third and fourth standard analyses and the third and fourth analytical splits have the poorest precision. These analyses have been flagged with an asterisk in Fig. 19.. The precision of the data set between the third analytical split and the fourth standard,corresponding to approximately 40% of the data, is therefore questionable. Samples from this range have been denoted with an asterisk in Table 6a. Insufficient ash was available to reanalyse the sample set.

There are no published regional biogeochemical surveys over Carboniferous basins on either Cape Breton Island or mainland Nova Scotia. The only major regional survey in Nova Scotia was conducted over the eastern Meguma Terrane (Dunn et al., 1989). It was decided that their data would not be used to establish contour intervals for our data set because of the dissimilarities in bedrock geology, and presumably geochemistry, of these two regions. Consequently the data was first ranked and then contour intervals were chosen to represent breaks in the data as described above.

Contour plots of Ba, Mn and Ag for the grid were prepared but no systematic patterns or correlations with either till or bedrock type were noted. Of particular interest is the lack of correlation between Ba concentration and the subcropping ore zone. This contradicts the postulation by Fortescue and Hornbrook (1969) that Ba should be an excellent biogeochemical "pathfinder" element for Yava-type deposits. It is possible that this lack of correlation is an artifact of poor analytical precision. Conversely, the problem of BaCl precipitation, as discussed in the previous section, may have masked the geochemical response for Ba.

The plot of Pb (Fig. 20a) clearly defines the projected subcrop of the east zone ore body,

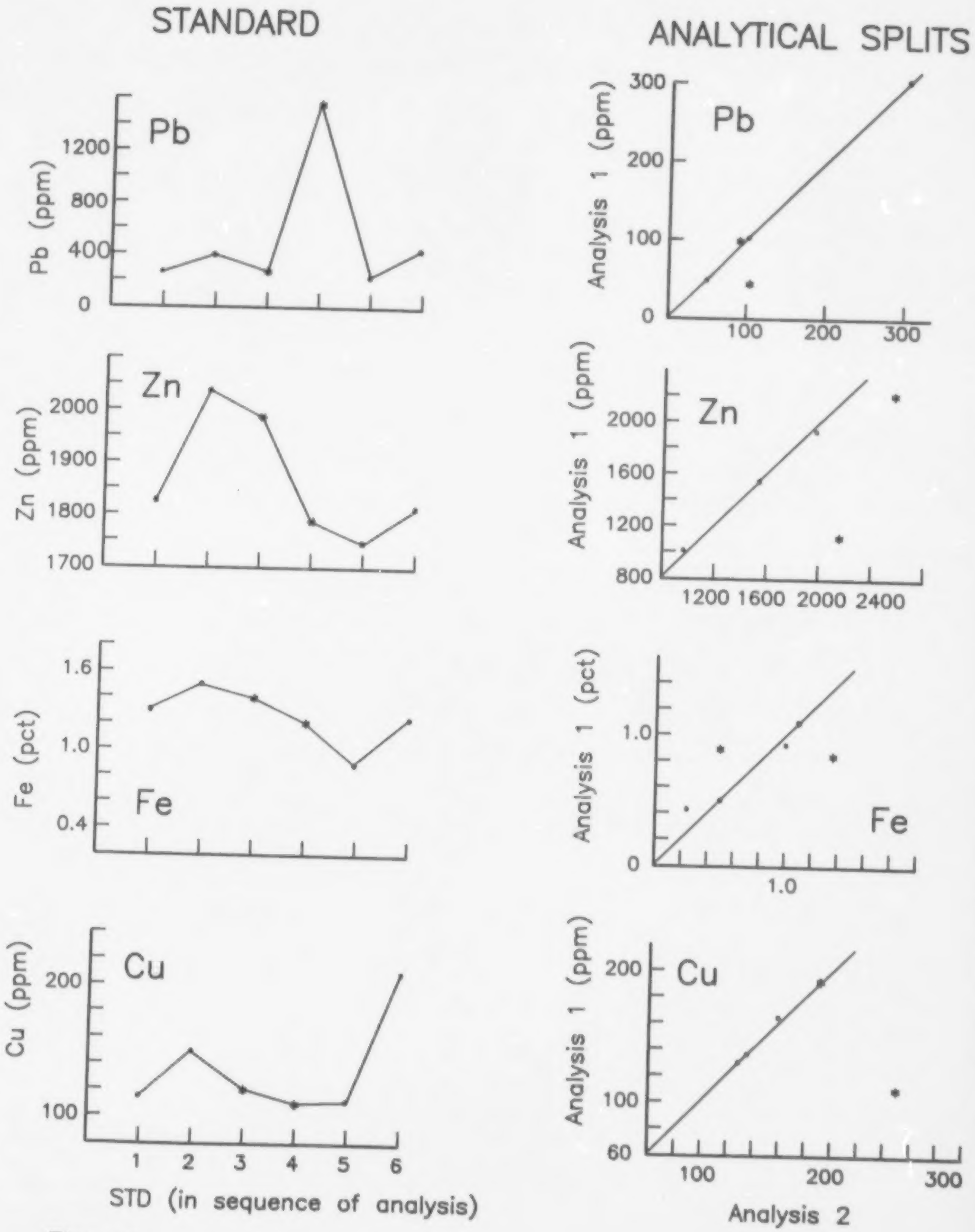

STANDARD
ANALYTICAL SPLITS
Pb
Pb (ppm)
0
400
800
1200
Zn
Zn (ppm)
1700
1800
1900
2000
Fe
Fe (pct)
0.4
1.0
1.6
Cu
Cu (ppm)
100
200
1
2
3
4
5
6
STD (in sequence of analysis)
Pb
Analysis 1 (ppm)
0
100
200
300
100
200
300
Zn
Analysis 1 (ppm)
800
1200
1600
2000
1200
1600
2000
2400
Fe
Analysis 1 (pct)
0
1.0
1.0
Cu
Analysis 1 (ppm)
60
100
200
100
200
300
Analysis 2

Figure 19

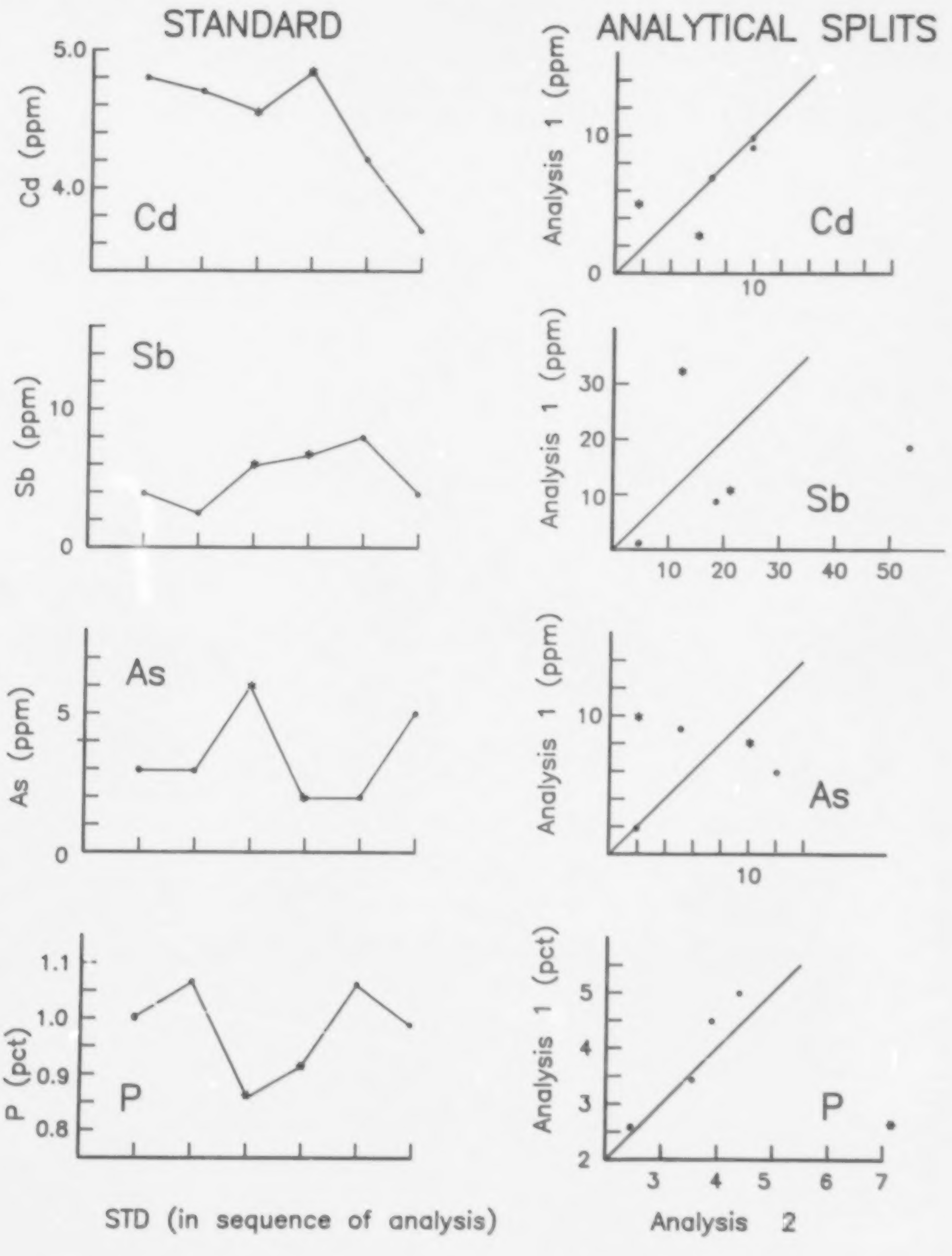

STANDARD
ANALYTICAL SPLITS
Cd (ppm)
5.0
4.0
Cd
Analysis 1 (ppm)
10
0
10
Cd
Sb (ppm)
10
0
Sb
Analysis 1 (ppm)
30
20
10
10
20
30
40
50
Sb
As (ppm)
5
0
As
Analysis 1 (ppm)
10
10
As
P (pct)
1.1
1.0
0.9
0.8
P
Analysis 1 (pct)
5
4
3
2
3
4
5
6
7
P
STD (in sequence of analysis)
Analysis 2

Figure 19

in spite of the observed analytical problems. Conversely, the plot of Zn (Fig. 20b) does not reflect the ore zone, as did the -230 mesh (-62.5 μm) till fraction, but rather defines a zone of enrichment in the north portion of the grid. A plot of Fe (Fig. 20c) defines an enriched zone that corresponds to the east ore zone. This high Fe may reflect an enrichment in pyrite, magnetite or other Fe-bearing heavy minerals in the ore body. Values for Cu (Fig. 20d) are somewhat erratic and resemble the patterns in the till data. There is an enrichment in Cd (Fig. 20e) in the Balsam Fir overlying the Silver Mine Formation compared to the rhyolite porphyry.

By far the most enigmatic aspect of the Balsam Fir data is the distribution of Sb and As (Figs. 20f and g). Both elements define robust, ribbon-shaped anomalies that trend perpendicular to the subcropping ore horizon and the Pb- and Zn-enriched zones that are defined in several sample media. The magnitude and consistency of these enrichments do not support an analytical origin. In fact, subsequent analysis of Balsam Fir needles from a select group of grid samples has confirmed the Sb and As distribution. There is no direct reference to northwest-trending geological features associated with the Yava deposit making these patterns somewhat puzzling. It is possible that the Balsam Fir are tapping a water system that interacts with a basement- or basin-related structure(s) such as faults or fracture systems. However, the root system of Balsam Fir is relatively shallow, being mostly restricted to the oxidized soil layer (0.4-1.0 metre deep). The lack of similar Sb and As patterns in the silt and clay fraction of the till samples from below this layer is also somewhat perplexing. Thus the exact geological explanation for the distribution of Sb and As in Balsam Fir twigs remains unclear.

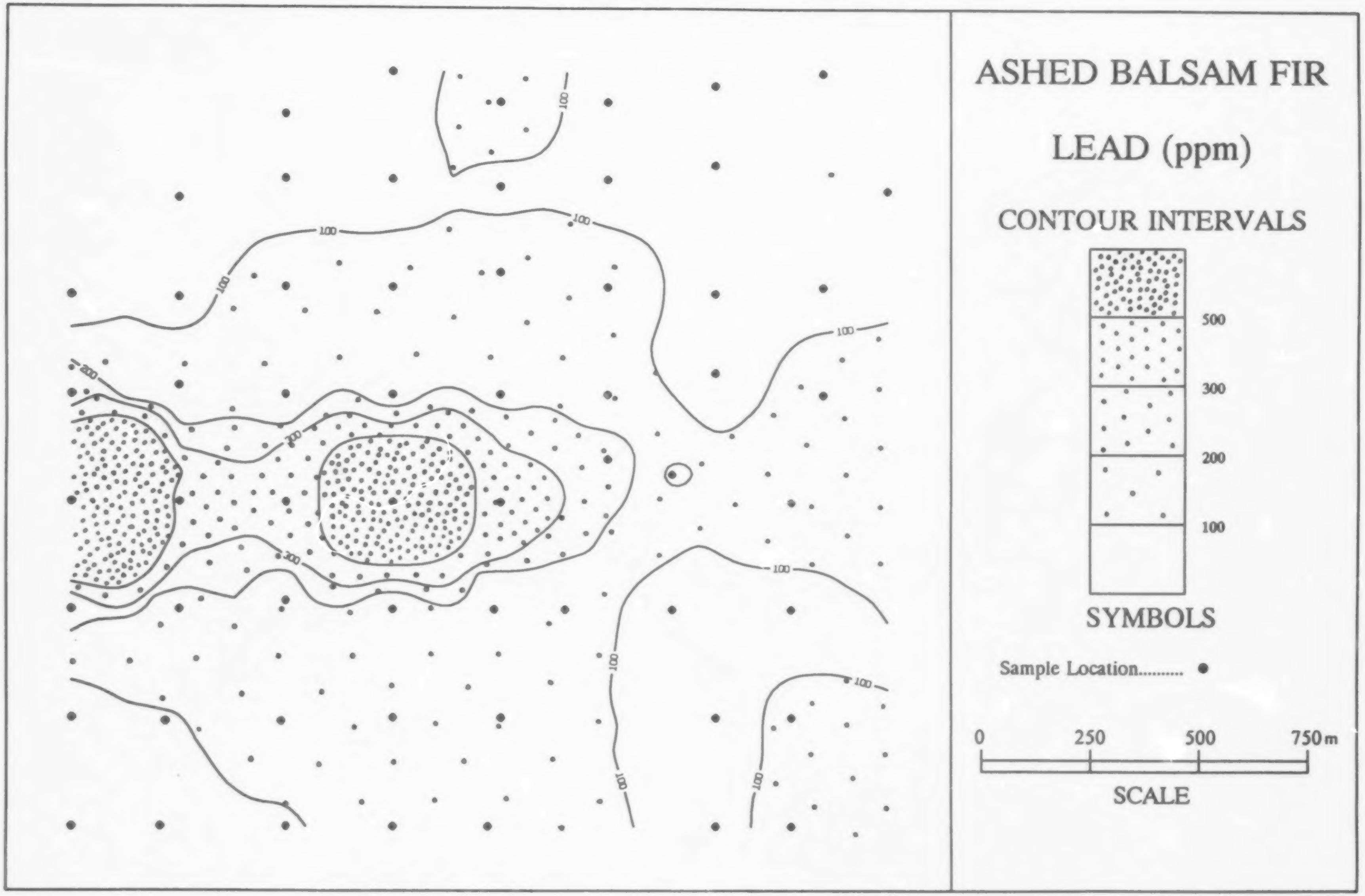

ASHED BALSAM FIR
LEAD (ppm)
CONTOUR INTERVALS
500
300
200
100
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
100
200
300

Figure 20a

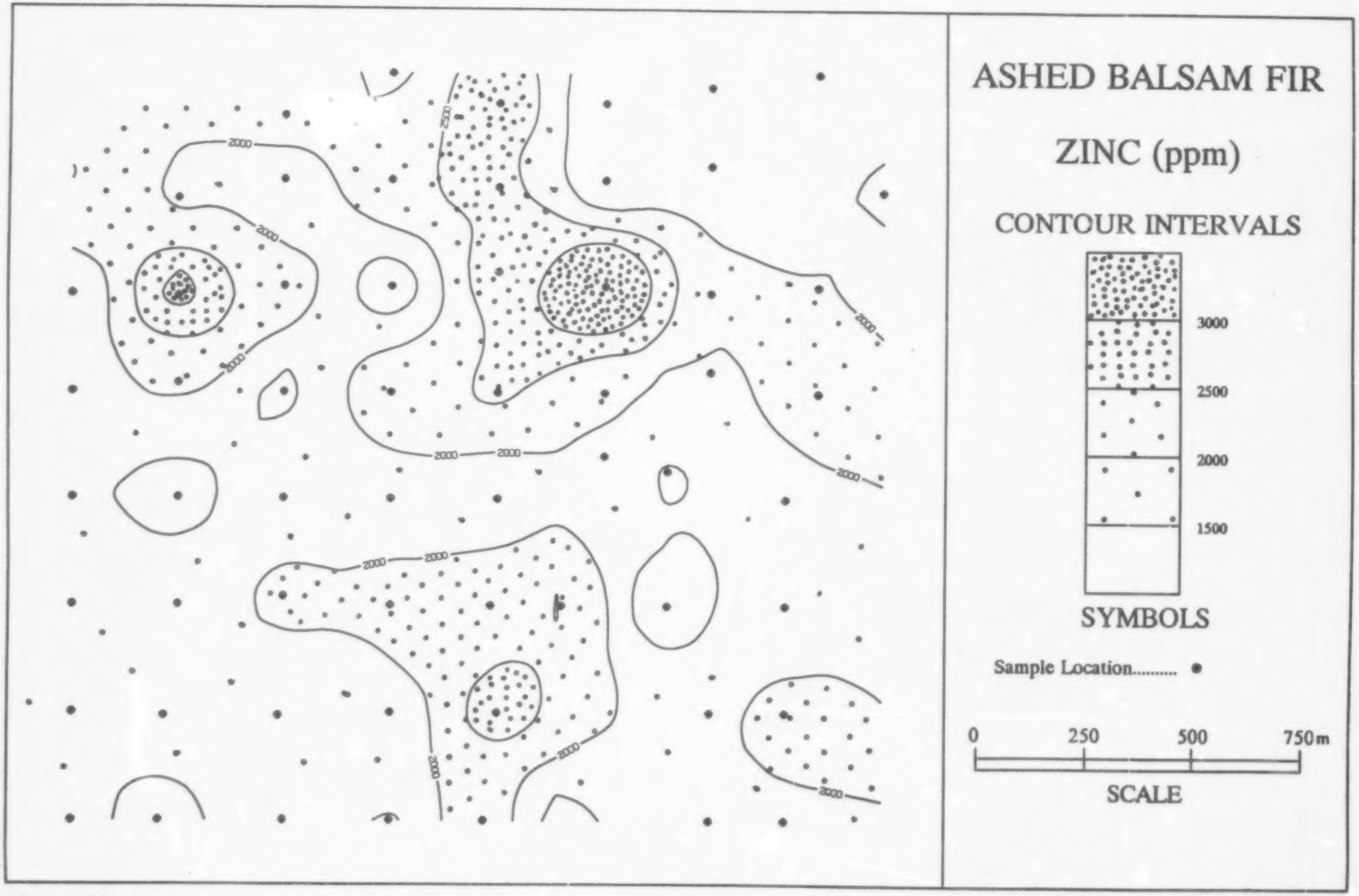

ASHED BALSAM FIR
ZINC (ppm)
CONTOUR INTERVALS
3000
2500
2000
1500
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
2000
2500

Figure 20b

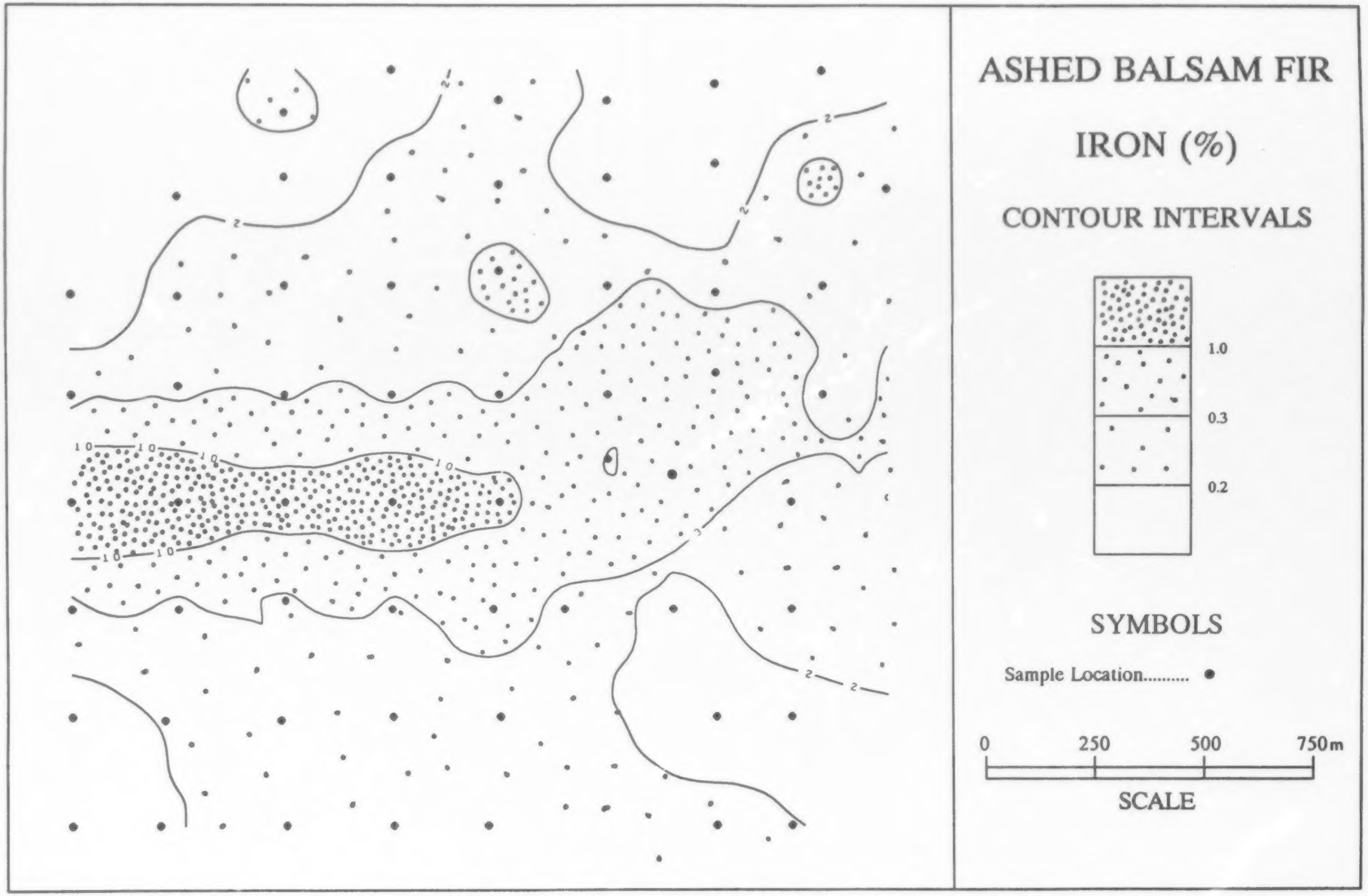

ASHED BALSAM FIR
IRON (%)
CONTOUR INTERVALS
1.0
0.3
0.2
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
2
1 0
3

Figure 20c

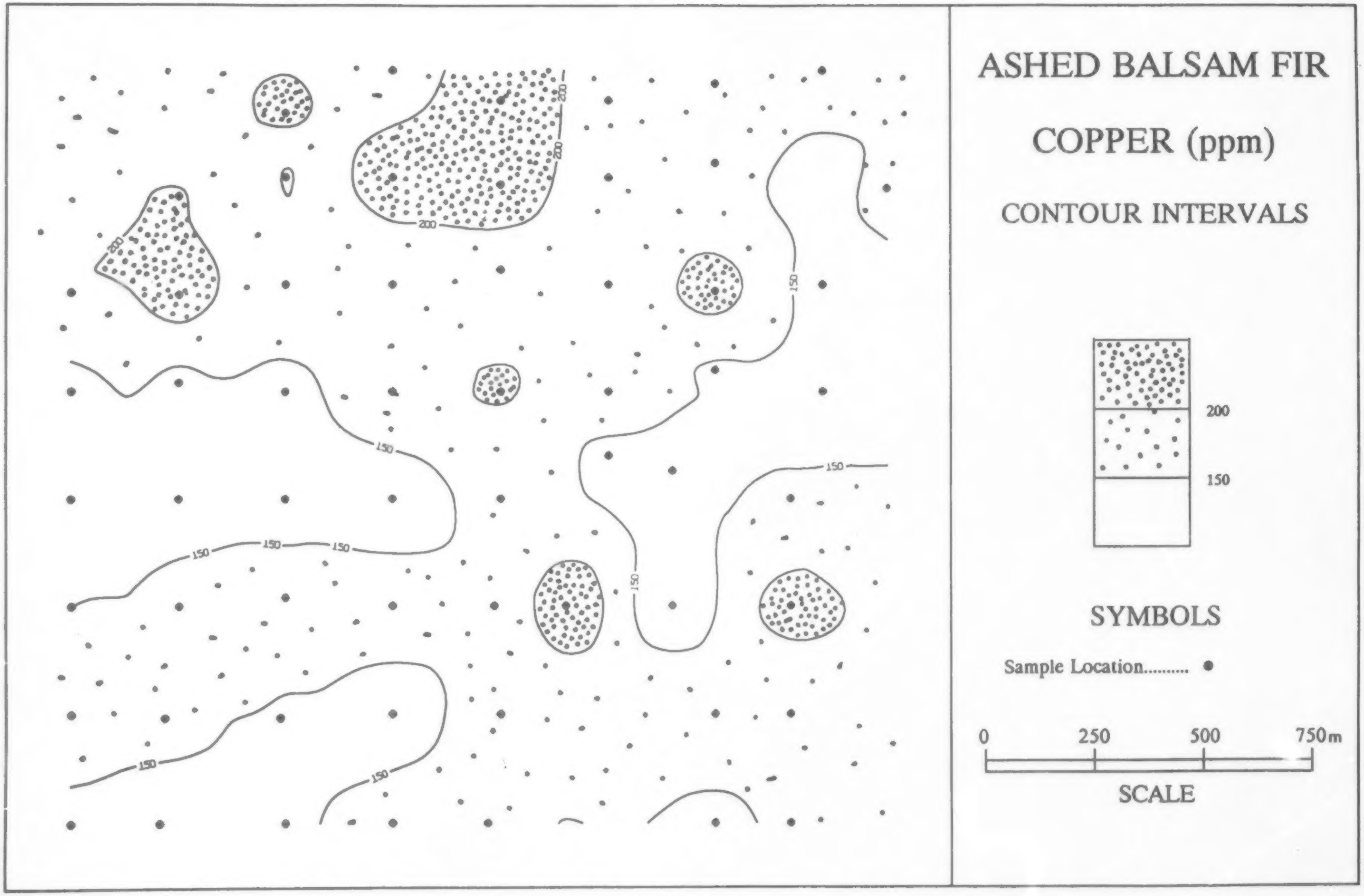

ASHED BALSAM FIR
COPPER (ppm)
CONTOUR INTERVALS
200
150
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
150
200

Figure 20d

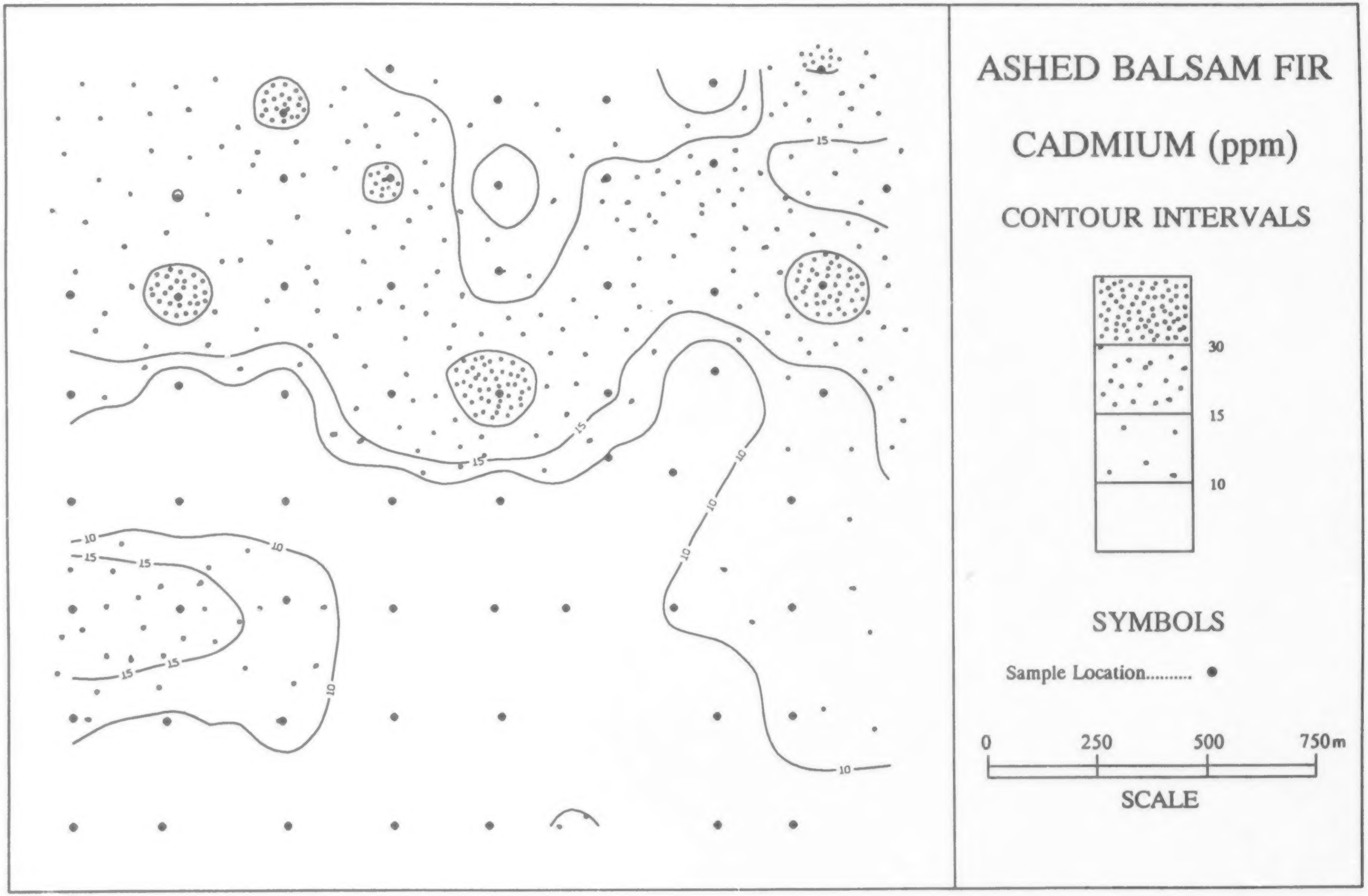

ASHED BALSAM FIR
CADMIUM (ppm)
CONTOUR INTERVALS
30
15
10
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
15
10

Figure 20e

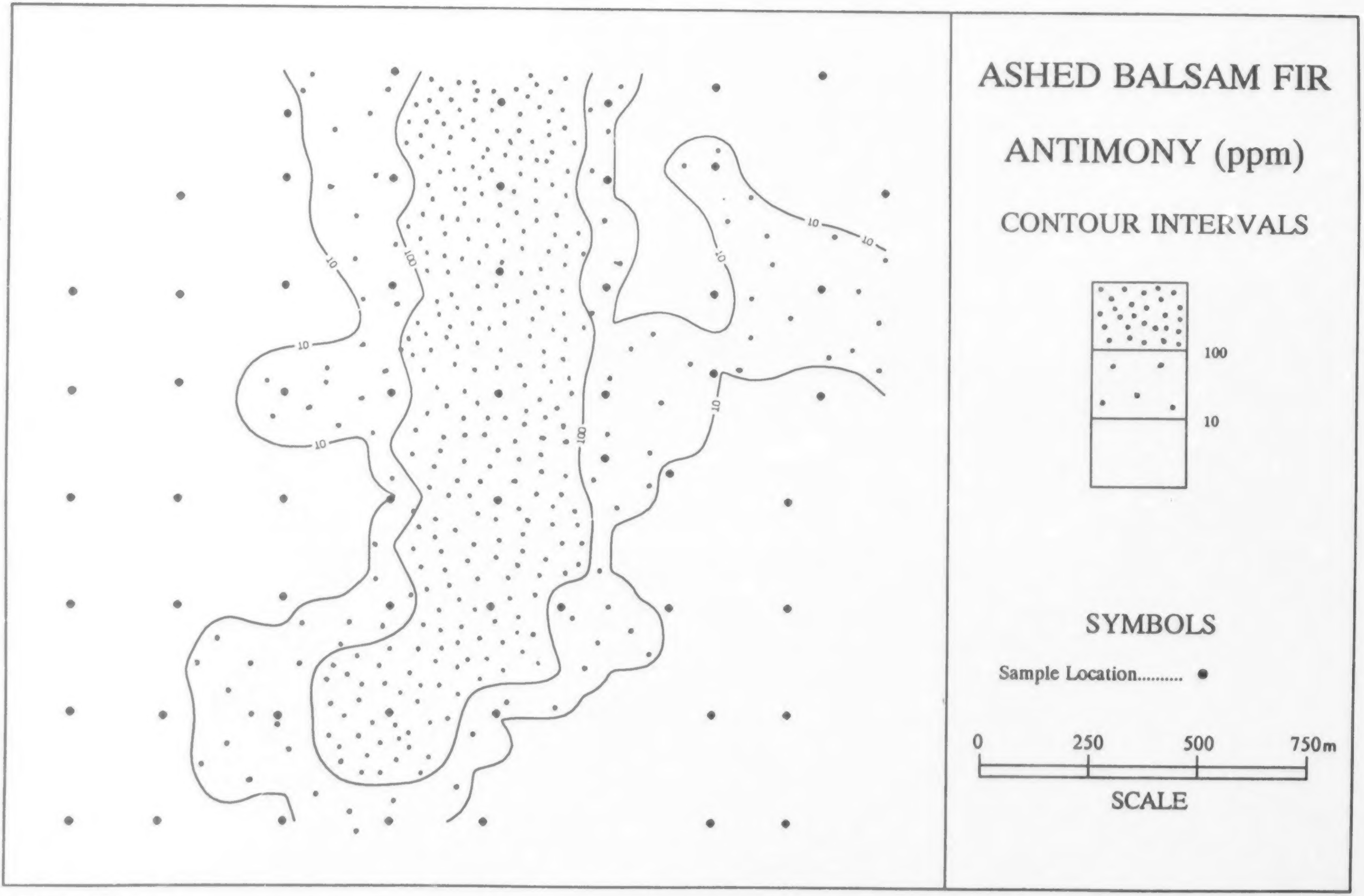

ASHED BALSAM FIR
ANTIMONY (ppm)
CONTOUR INTERVALS
100
10
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
10
100

Figure 20f

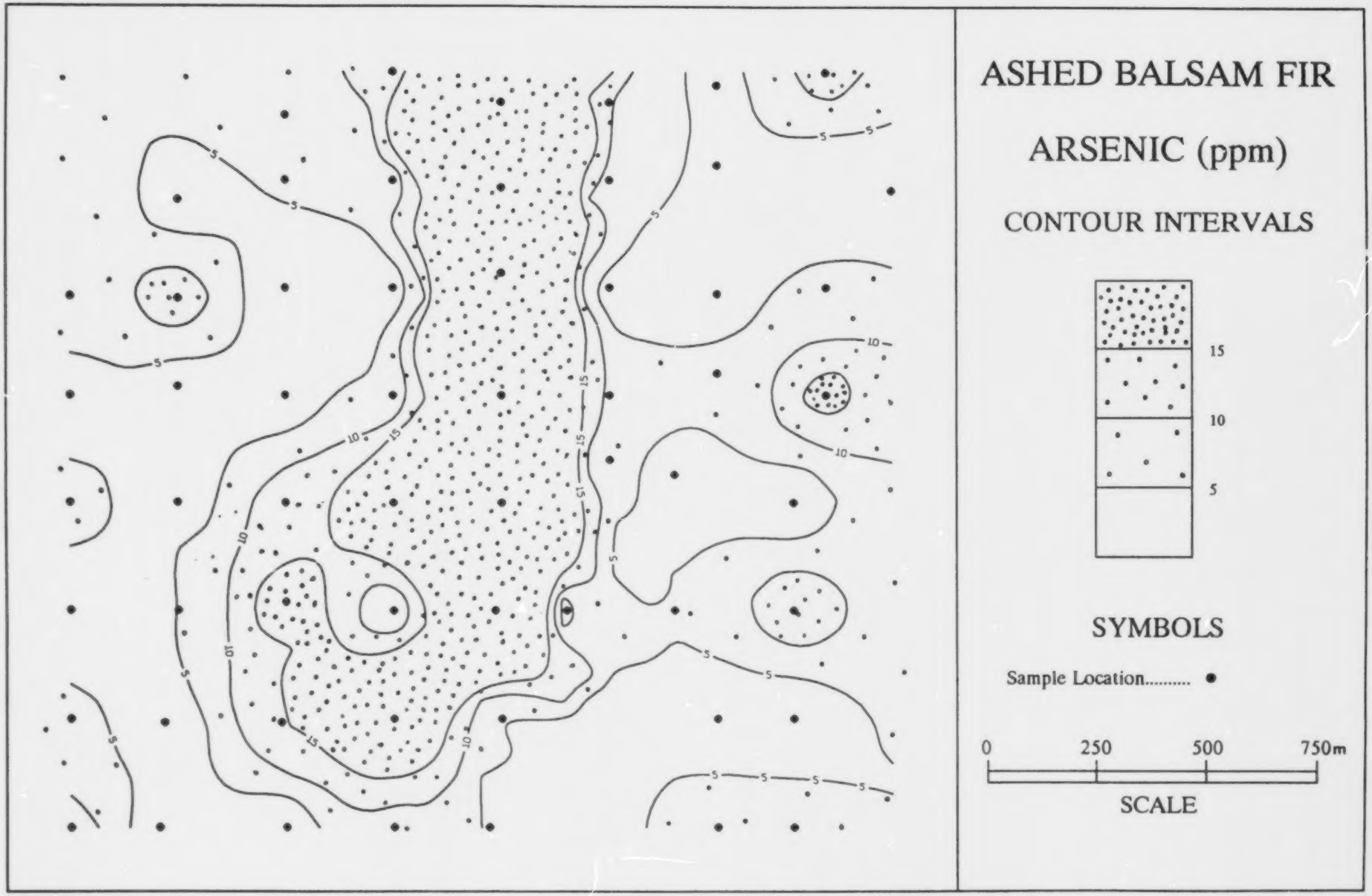

ASHED BALSAM FIR
ARSENIC (ppm)
CONTOUR INTERVALS
15
10
5
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
5
10
15

Figure 20g

## 9.3 Humus

The -80 mesh (-177 µm) fraction of the oven-dried organic humus ("A" soil horizon) samples were sent to Bondar Clegg Company Ltd. of Ottawa Ontario for analysis by the 38 element ICP-AES analytical package. This is the same technique that was employed for the -230 mesh (-62.5µm) fraction of both till and stream sediment samples. Approximately 0.5 gm of sample was digested in a LeFort Aqua-Regia (HCl-$HNO_3$, 1:3) digestion prior to analysis.

In general, the concentrations of most elements were much lower than encountered in either the -230 mesh (-62.5µm) fraction of till samples or in the ashed Balsam Fir. Many elements were either entirely below detection limits or were present in such low concentrations that analytical precision was very poor. These elements include Ti, P, Li, Be, Ga, Rb, Y, Zr, Nb, Mo, Sn, Sb, Te, La, Ce, Ta, W and Bi. Analytical results for the remaining 20 elements (Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, Sr, Cd, V, Ca, Sc, Cr, Mg, Ba, Al, Na and K) are given in Table 7a of Appendix A. Analytical data for standards, sample splits and field duplicates are given in Tables 7b - 7d respectively.

No regional organic humus surveys have been conducted in Nova Scotia, consequently it was not possible to calculate statistically-derived inspection levels for the purpose of data evaluation. The contour intervals for Figs. 21a to h have therefore been selected to best represent the data as outlined at the beginning of this section.

Analytical data for Pb and Zn have been contoured and are presented in Figs 21a and b. Both Pb and Zn show substantial enrichment predominantly in the northeastern portion of the grid. These areas of enrichment are "displaced" approximately 250-500 m northward from the "anomalies" in the -230 mesh (-62.5µm) fraction and -60+230 mesh (-250+62.5 µm) fraction heavy mineral separates from till samples and the ashed Balsam Fir. The area with the highest Pb and Zn concentrations in the humus survey is, for the most part, along the flanks of the prominent drumlin located northeast of the subcropping ore zone (Figs 10 and 13). Some of the highest values are close to the stream. The displacement of the Pb- and Zn-enriched zones into a predominantly low, and often swampy, area suggests that some hydromorphic dispersion has occurred. This is consistent with the results of a "soil" survey over the deposit (Geisler, 1963; Figs 5a and 5b) as discussed earlier.

Contour plots of Fe and Mn are given in Figs 21c and d. The highest values for both elements occur in samples #12, 21 and 28. Interestingly, these are the samples with some of the highest Pb and Zn concentrations. It is therefore possible that much of the Pb and Zn in these samples was scavenged by Fe and Mn which is a common geochemical phenomenon (Levinson, 1974). In fact, many recent "A" horizon surveys have experimented with the use of correction factors where the concentration of a given element is corrected for the associated concentrations of Fe and/or Mn (G.E.M. Hall, pers. comm., 1991). The possible effects of elevated levels of Mn and Fe was being investigated at the time of release of this report and will be outlined in future reports.

In contrast to the distribution of Pb and Zn in the grid area (Figs. 21a and b), a plot of Ag values (Fig. 21e) pin-points the east zone ore subcrop. In fact, the distribution of Ag in humus very closely resembles that of the heavy mineral till data. In contrast the Ag distribution for both the silt and clay fraction of tills and the ashed Balsam Fir are erratic and do not reflect either bedrock geology or location of the deposit.

Contour plots of Cu, As and Cd are presented in Figs 21f to h. All three elements display irregular distributions with no apparent relationship to the major geological features (Fig. 13).

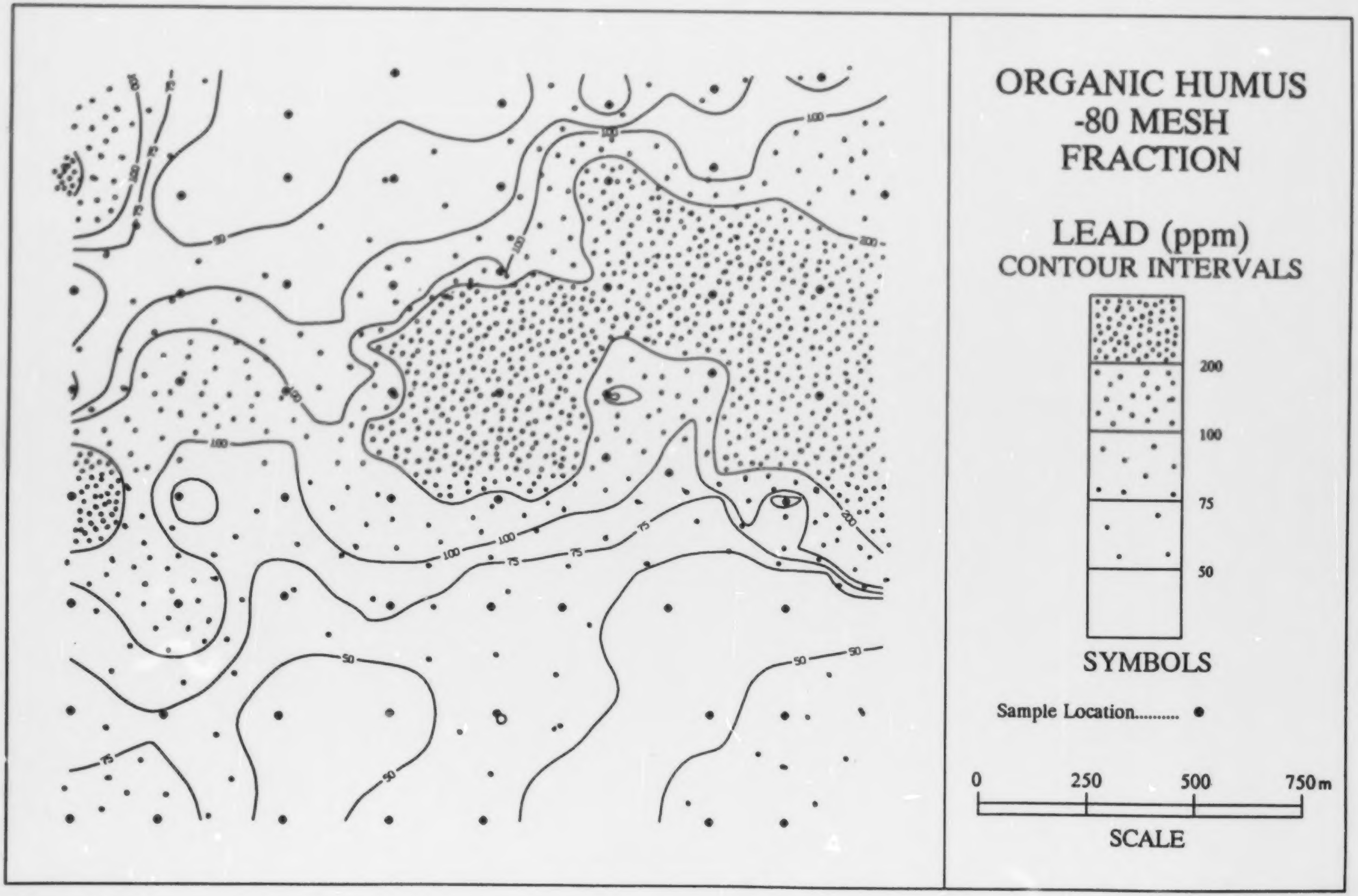

ORGANIC HUMUS
-80 MESH
FRACTION
LEAD (ppm)
CONTOUR INTERVALS
200
100
75
50
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
100
200
75
50

Figure 21a

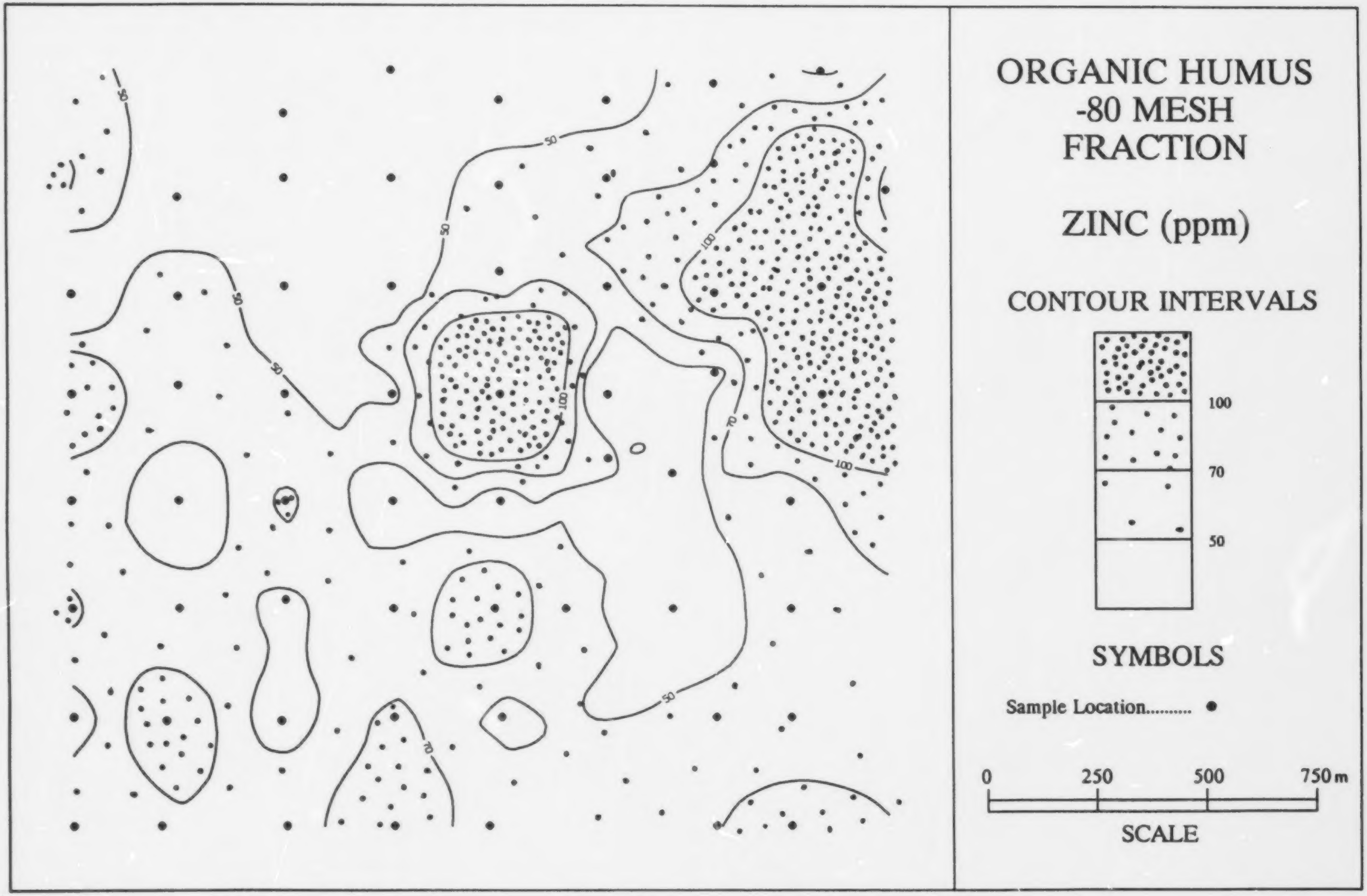

ORGANIC HUMUS
-80 MESH
FRACTION
ZINC (ppm)
CONTOUR INTERVALS
100
70
50
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
50
100
70

Figure 21b

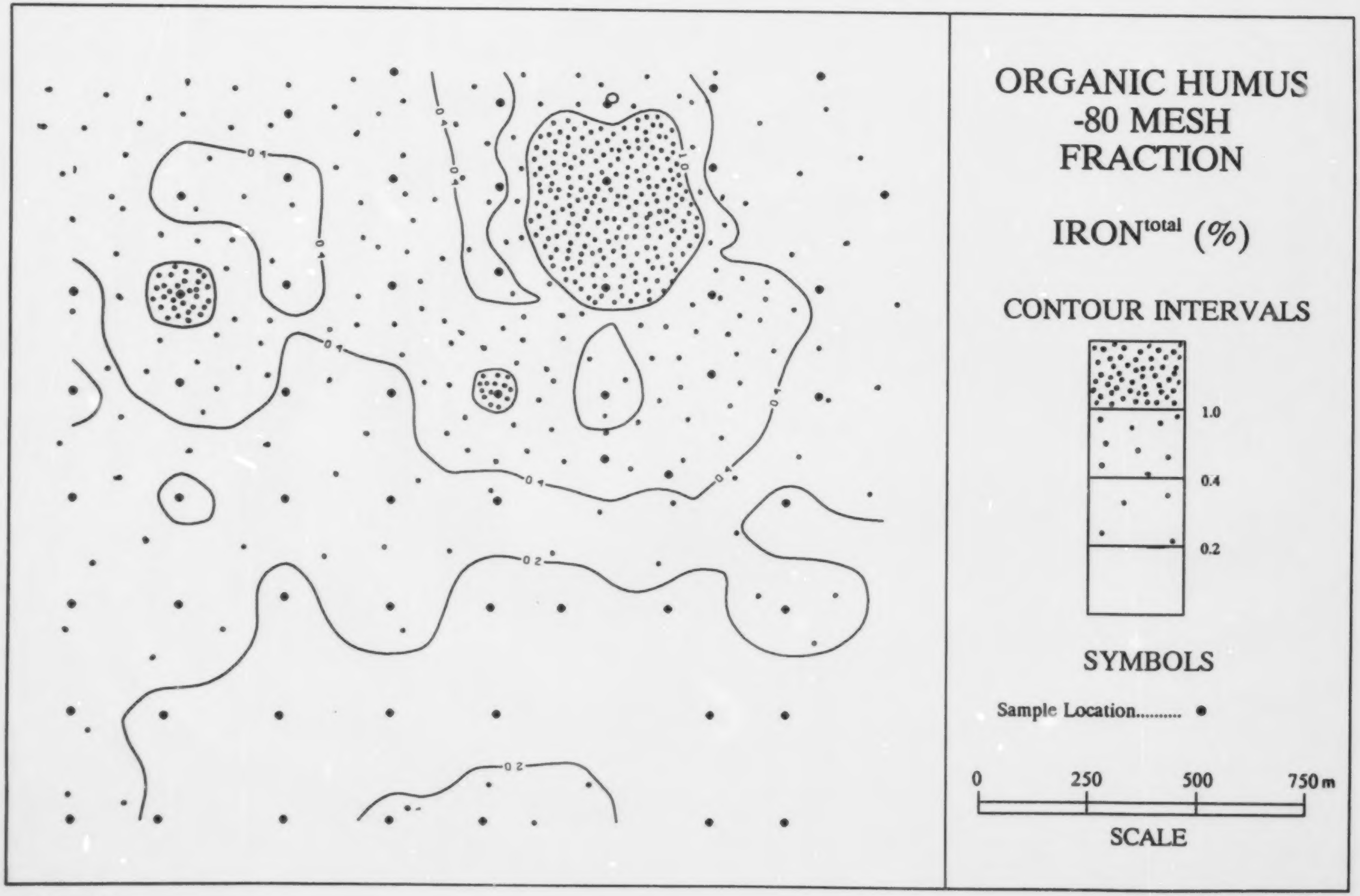

ORGANIC HUMUS
-80 MESH
FRACTION
IRON$^{total}$ (%)
CONTOUR INTERVALS
1.0
0.4
0.2
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
1.0
0.4
0.2

Figure 21c

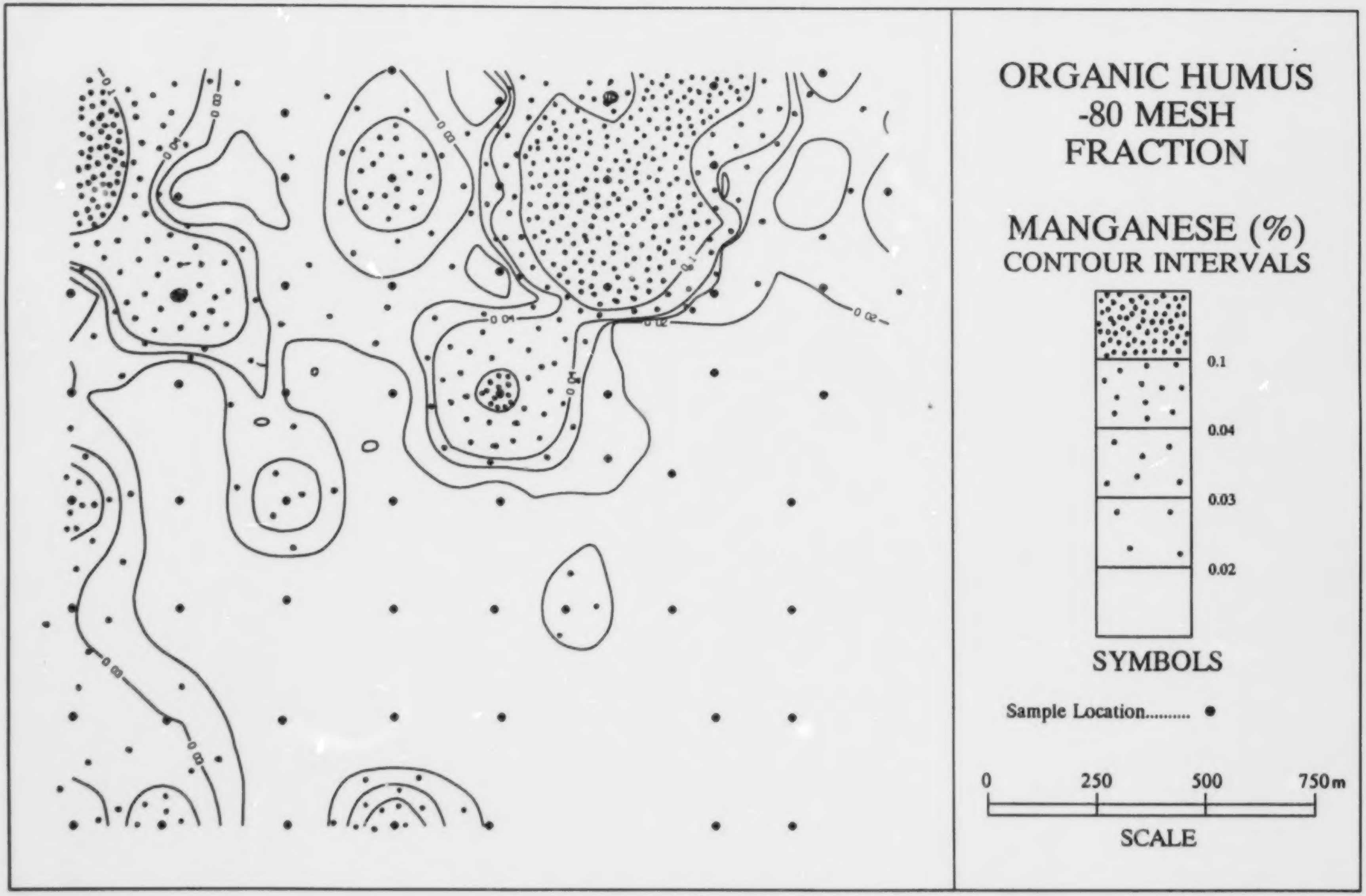

ORGANIC HUMUS
-80 MESH
FRACTION
MANGANESE (%)
CONTOUR INTERVALS
0.1
0.04
0.03
0.02
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
0.03
0.04
0.1
0.02

Figure 21d

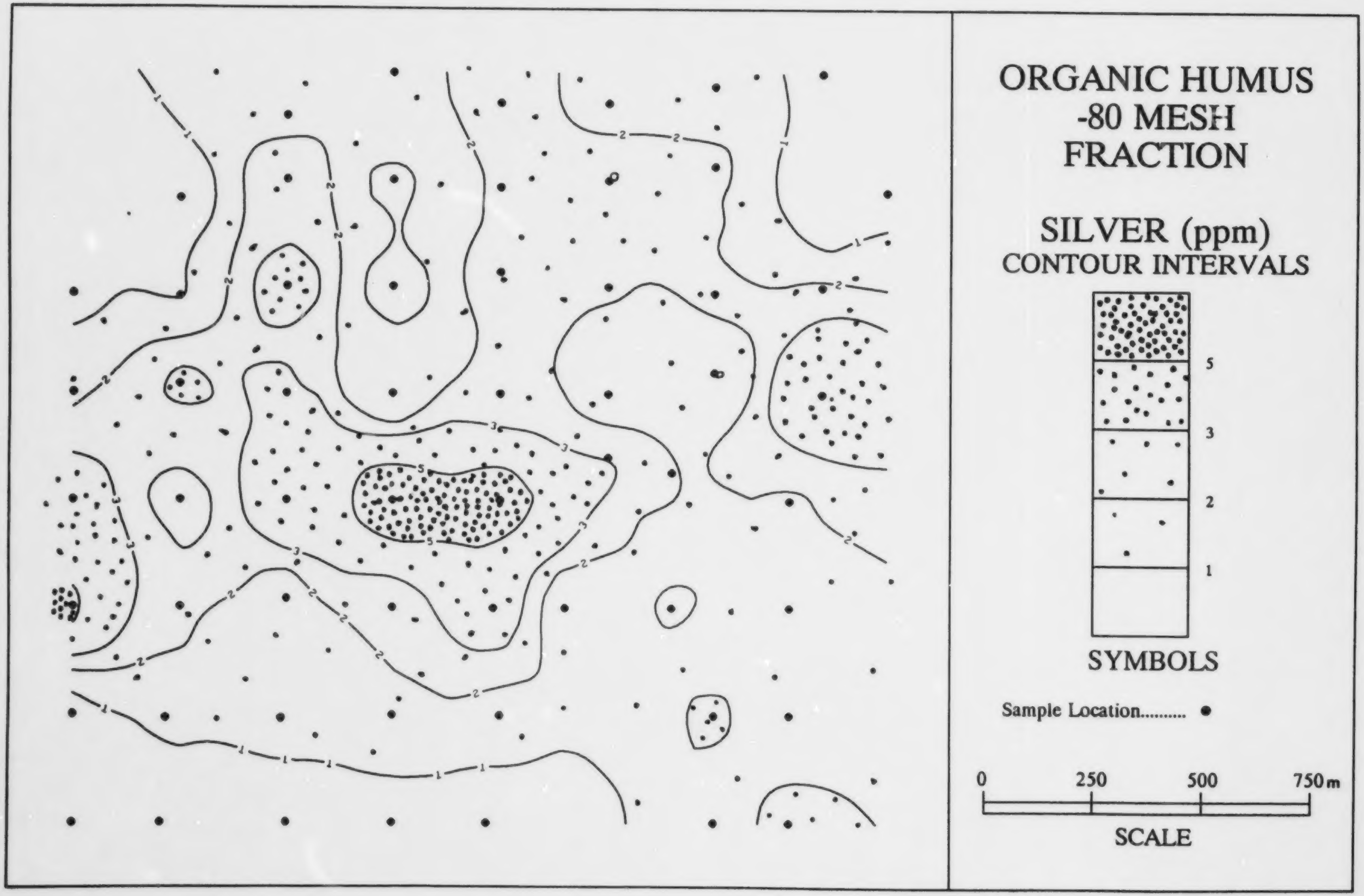

ORGANIC HUMUS
-80 MESH
FRACTION
SILVER (ppm)
CONTOUR INTERVALS
5
3
2
1
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
1
2
3
5

Figure 21e

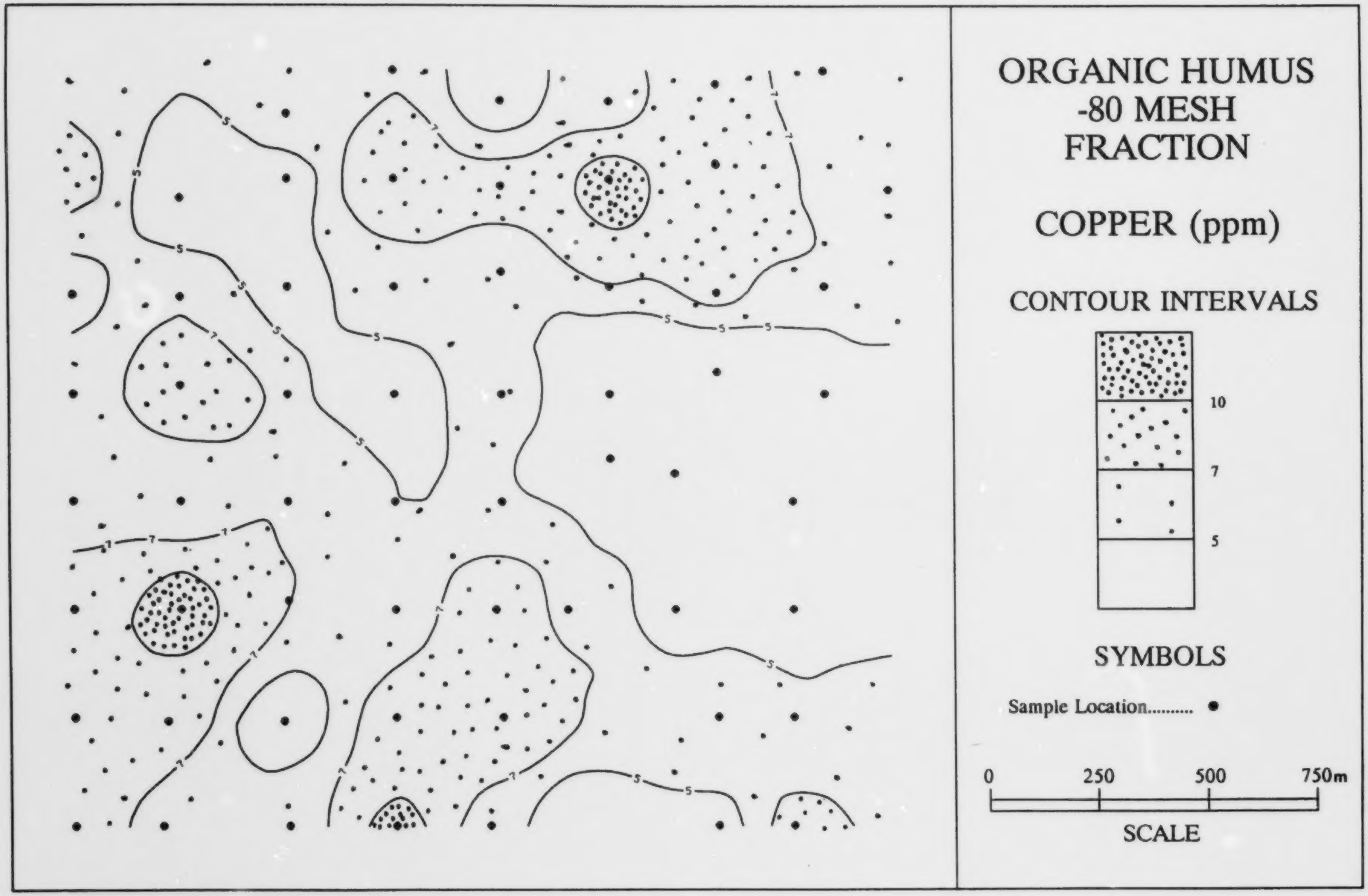

ORGANIC HUMUS
-80 MESH
FRACTION
COPPER (ppm)
CONTOUR INTERVALS
10
7
5
SYMBOLS
Sample Location.......... ●
0
250
500
750m
SCALE
5
7

Figure 21f

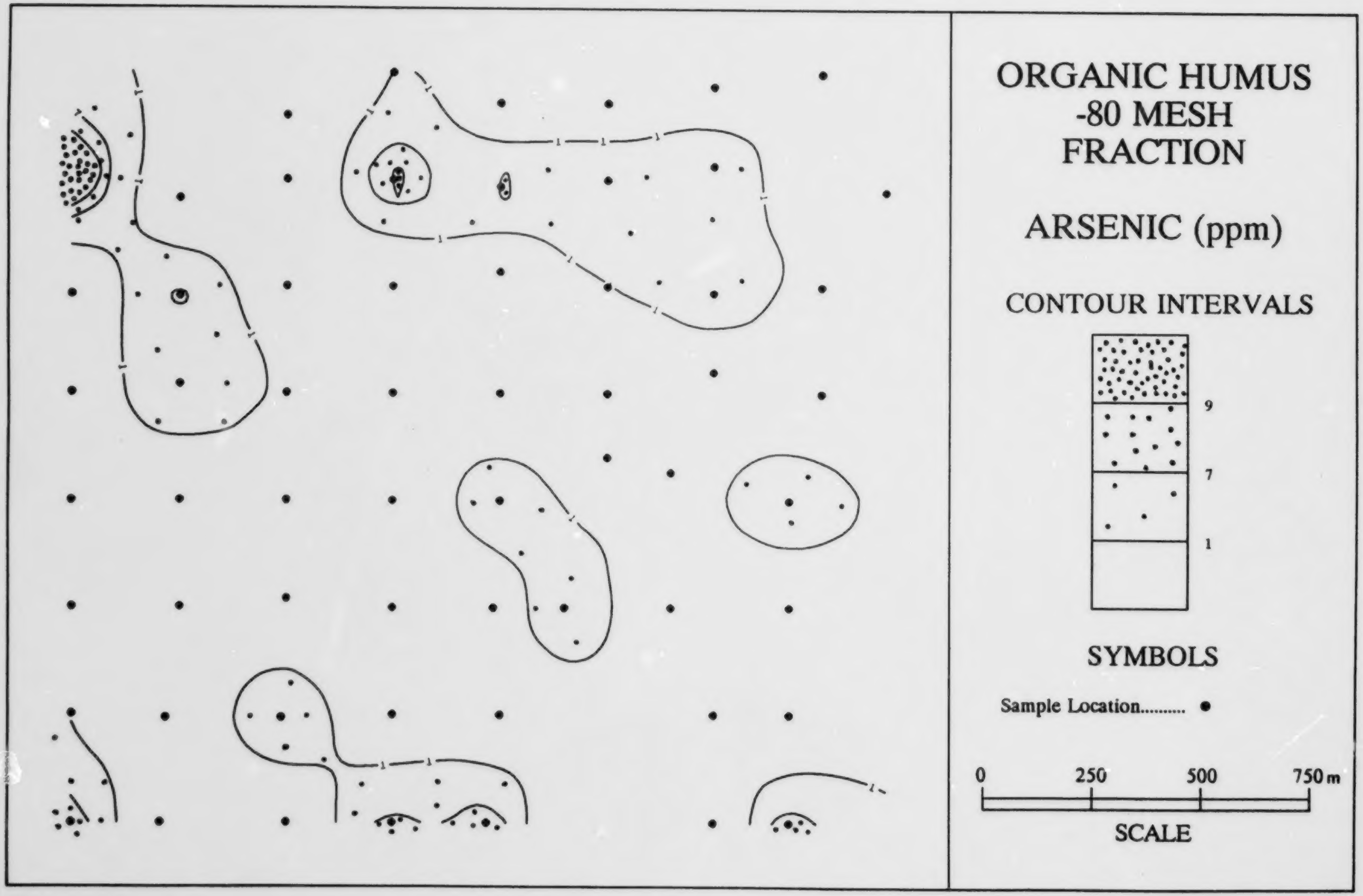

ORGANIC HUMUS
-80 MESH
FRACTION
ARSENIC (ppm)
CONTOUR INTERVALS
9
7
1
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
1

Figure 21g

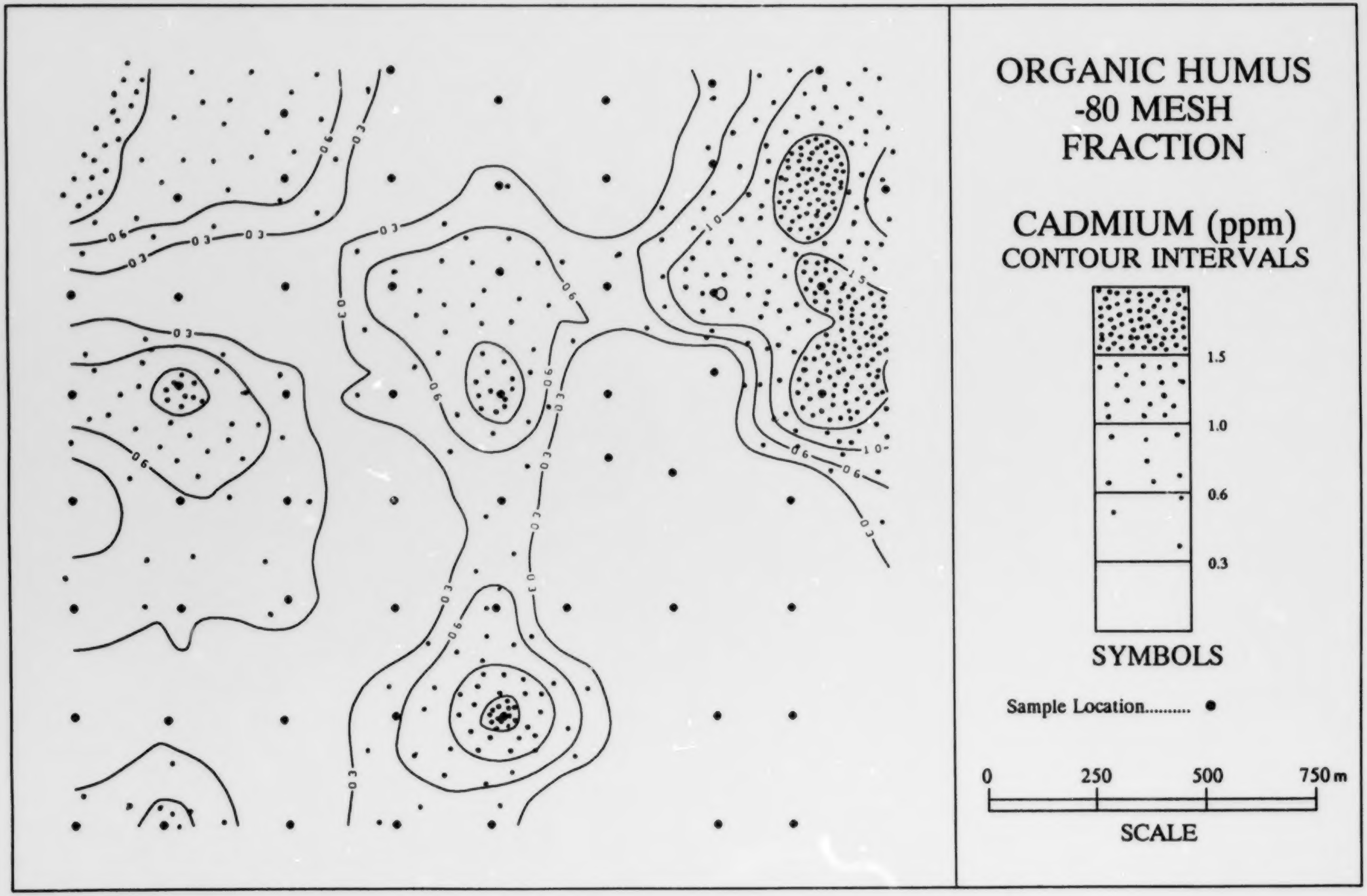

ORGANIC HUMUS
-80 MESH
FRACTION
CADMIUM (ppm)
CONTOUR INTERVALS
1.5
1.0
0.6
0.3
SYMBOLS
Sample Location.......... ●
0
250
500
750 m
SCALE
0.3
0.6
1.0
1.5

Figure 21h

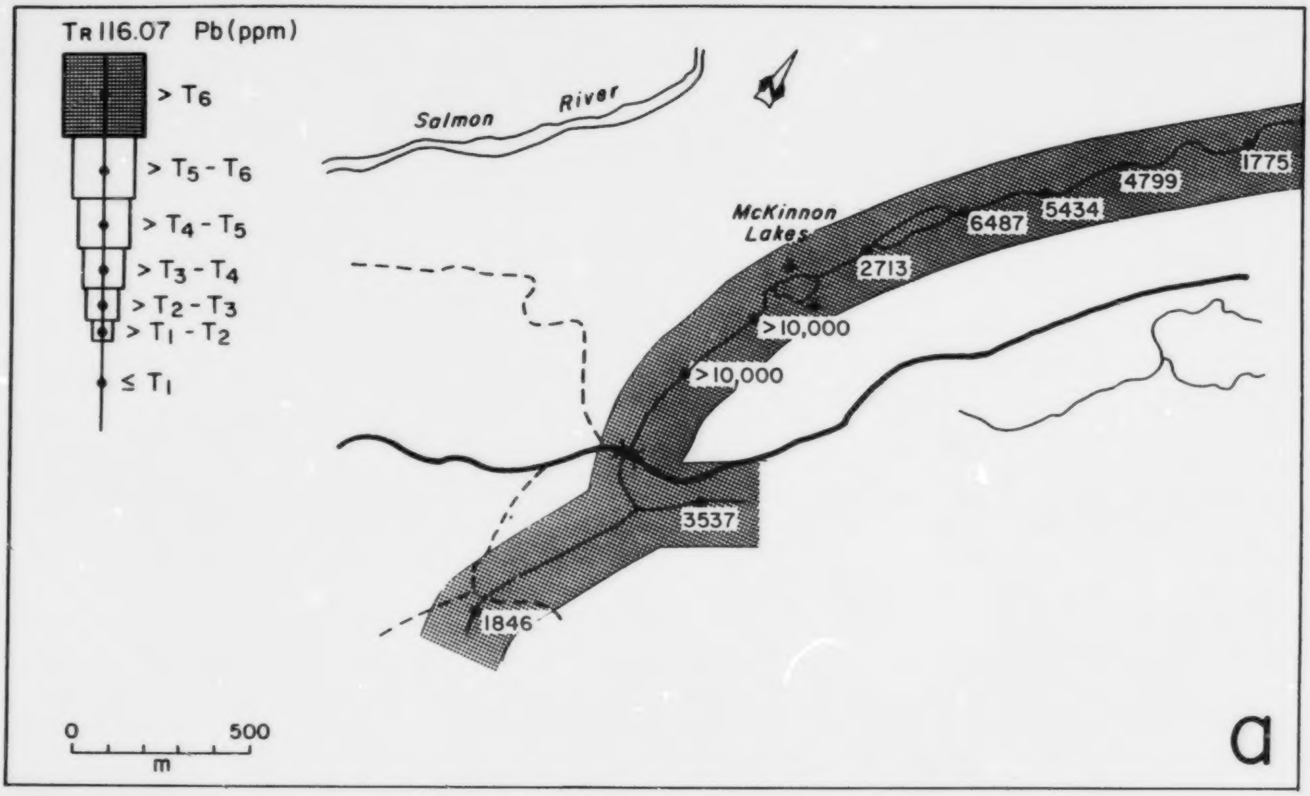
## 9.4 Stream sediments

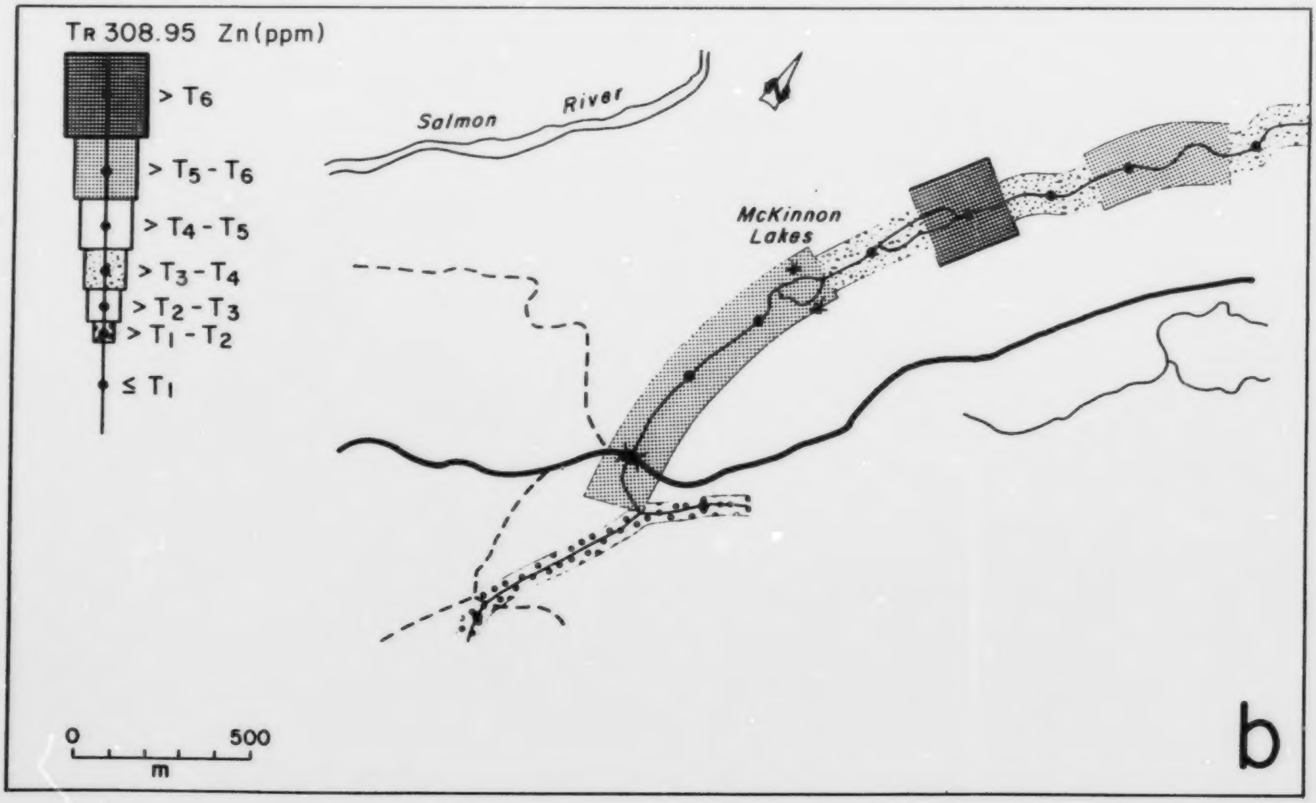
### 9.4.1 Minus 230 fraction

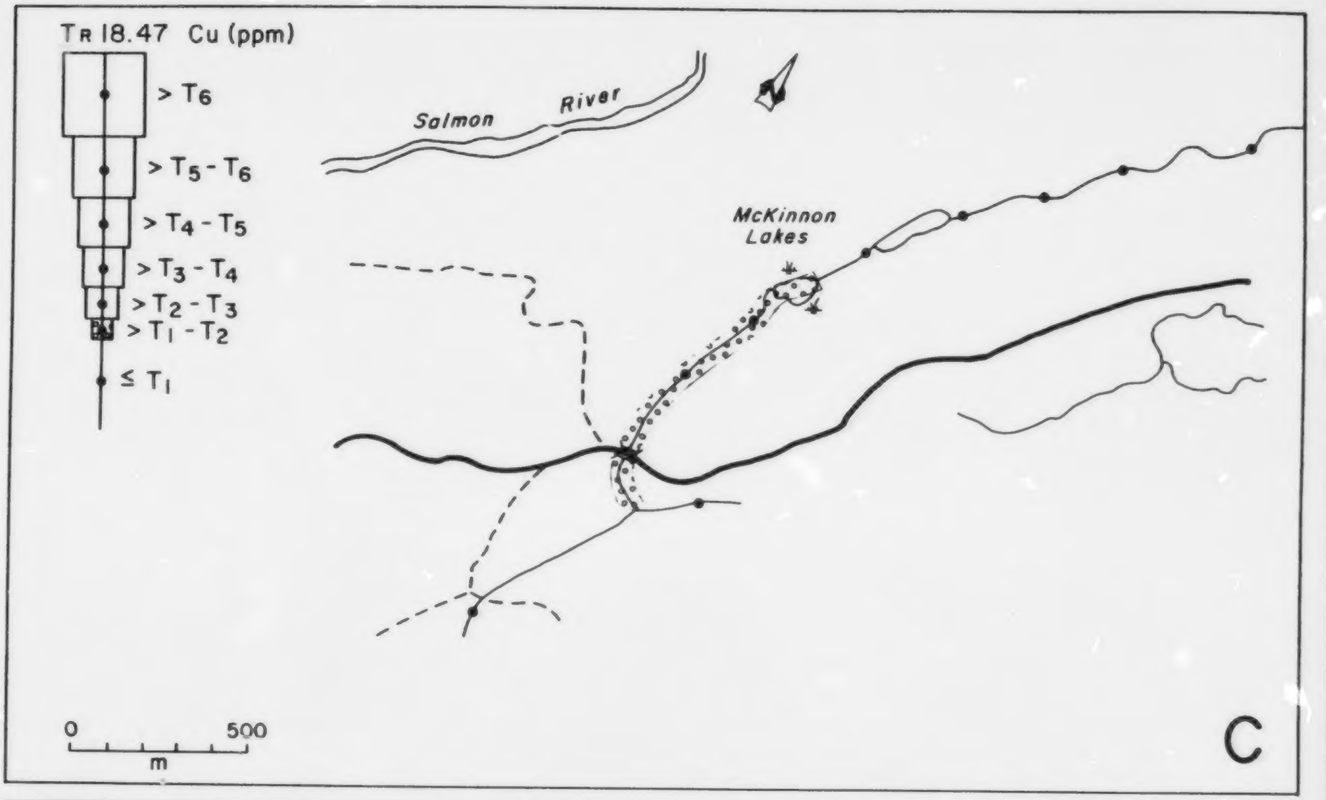
The -230 mesh (-62.5μm) fraction of the stream sediments were digested and analysed at Bondar Clegg Co. Ltd in Ottawa using the same techniques as described above for the -230 mesh (-62.5μm) till matrix fractions. Analytical results for the nine samples are given in Table 8 of Appendix A. Data is presented for 17 trace elements (Li, Sc, V, Cr, Co, Ni, Cu, Pb, Zn, As, Sr, Y, Zr, Ag, Ba, La and Ce) and 4 major elements (Al, Fe, Mn and Mg). Several elements including Be, Ga, Rb, Nb, Mo, Cd, Sn, Sb, Te, Ta, W, Ti, Ca, Na, K and P were either entirely below detection limit or present in extremely low concentrations. Additionally, most of these elements showed no notable correlation to either rock type or proximity to the ore zone and have been omitted from Table 8. Analytical results for standards, analytical sample splits and field duplicates are the same as for the -230 mesh (-62.5μm) till matrix data set and are given in Tables 4b-4d. Regional stream sediment data from Rogers and MacDonald (1986) and Mills (1989) was used to establish inspection values as outlined at the beginning of this section. Rogers and MacDonald (1986) provide the basic statistics ($X_R$, $[\text{std dev}]_R$ and range) for Fe, Mn, Co, Ni, Cu, Pb, Zn, As, Mo and Ag. It should be stressed that, as discussed above in section 3, their calculations were performed on a composite data set that included both stream and lake sediments. A cursory inspection of the data indicates that there are significant variations in the trace and major element concentrations between these two sample media. This will artificially elevate or lower the stream "thresholds", and vica versa the lake "thresholds". A much more rigorous method of threshold calculations for this study would involve the determination of the means and std. devs. for only the stream sediments that overlie the GHG. It was decided that the data from Rogers and MacDonald (1986) would be used for the purpose of this communication. It is worthy of note that their regional data used an aqua regia partial dissolution of -80 mesh (-177 μm) fraction with analysis by atomic absorption spectrometry (AAS). This size fraction is substantially coarser than the -230 (-62.5 μm) fraction utilized in this report.

Mills (1989) provides basic statistics ($X_R$, $[\text{std dev}]_R$, and range) for a Al, Fe, Mn, Li, V, Co, Ni, Cu, Zn, Rb, Ag, Cd, Ba and Bi. Mean concentrations for Fe (4.53%) and Mn (0.35%) are significantly higher than values from Rogers and MacDonald (1986; 2.29% and 0.28% respectively). In contrast, the mean values for Cu, Zn and Ag (14.70, 155.48 and 0.28 ppm) more closely resemble those of Rogers and MacDonald (1986; 16.77, 206.81 and 0.19 ppm). These statistical dissimilarities yield significant differences in resulting thresholds. The different elemental concentrations are thought to arise from the use of a total acid digestion ($HF$-$HCLO_4$-$HNO_3$-$HCL$) in the regional survey of Mills (1989). Therefore inspection levels or "thresholds" were calculated using the data of Rogers and MacDonald (1986) for all elements except Al, Li, V, Ba and Bi where the data of Mills (1989) was used.

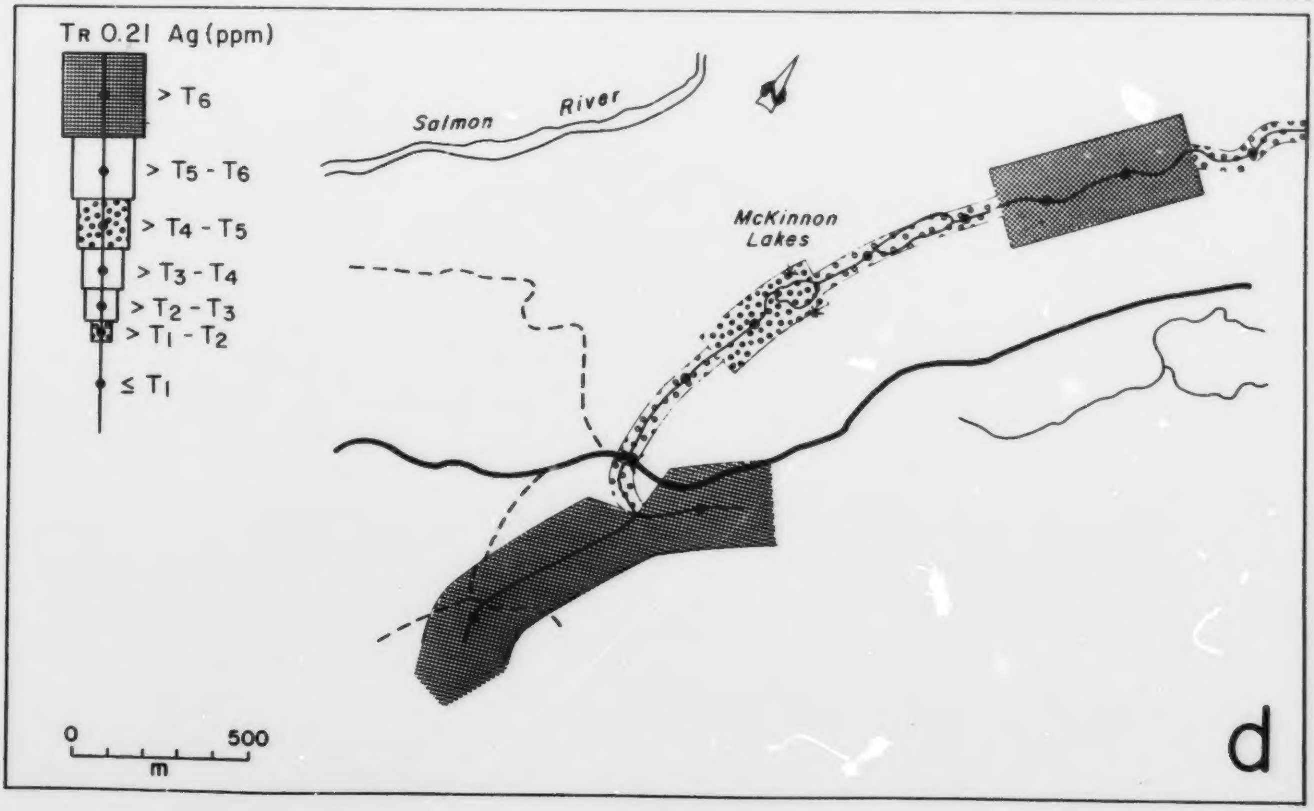
Plots were prepared for Pb, Zn, Cu, Ag, As, Mo, Mn, Fe, Ni, Co and Ba and are presented in Figs 22a to k. It should be noted that the approximate location of the subcrop of the east zone ore horizon is approximately where the road crosses the stream (Fig. 13). The most


TR 116.07 Pb(ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
1775
4799
5434
6487
2713
>10,000
>10,000
3537
1846
0
500
m
a

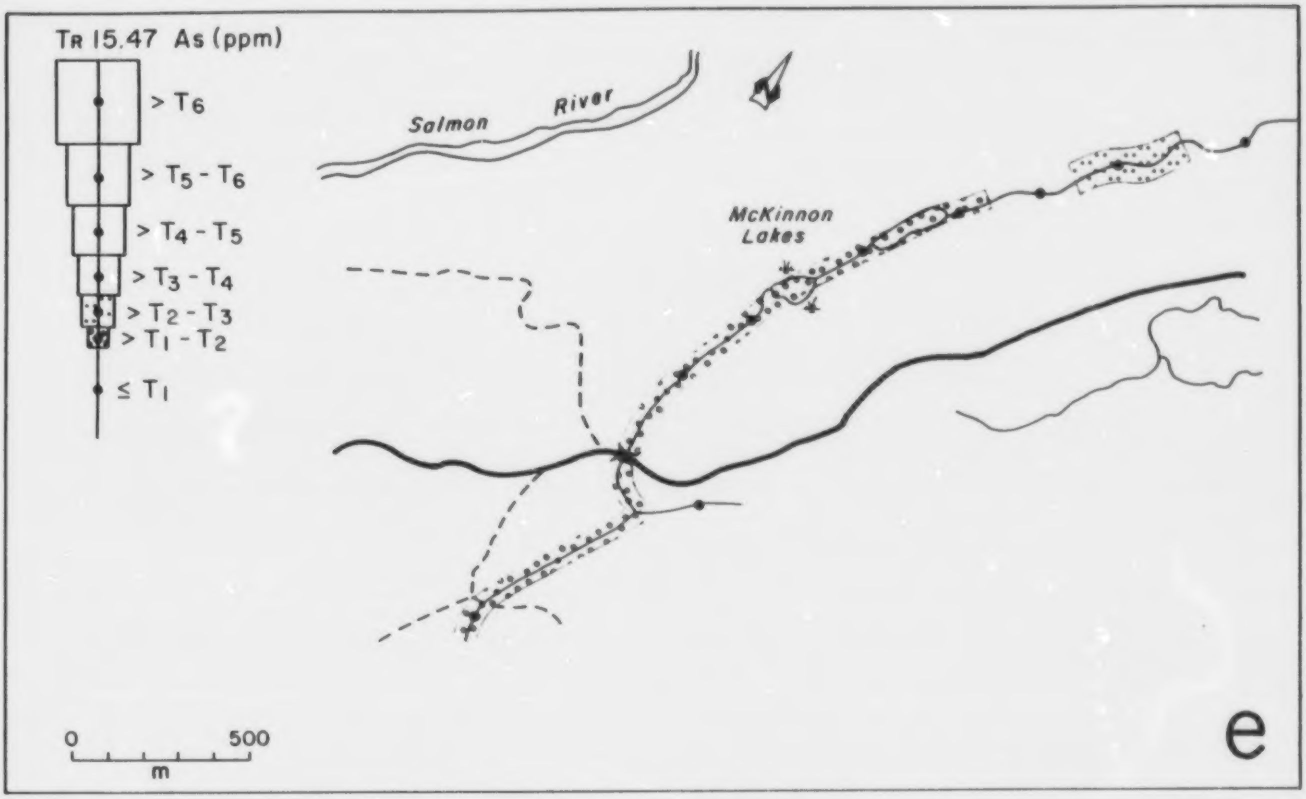

TR 308.95 Zn(ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
b

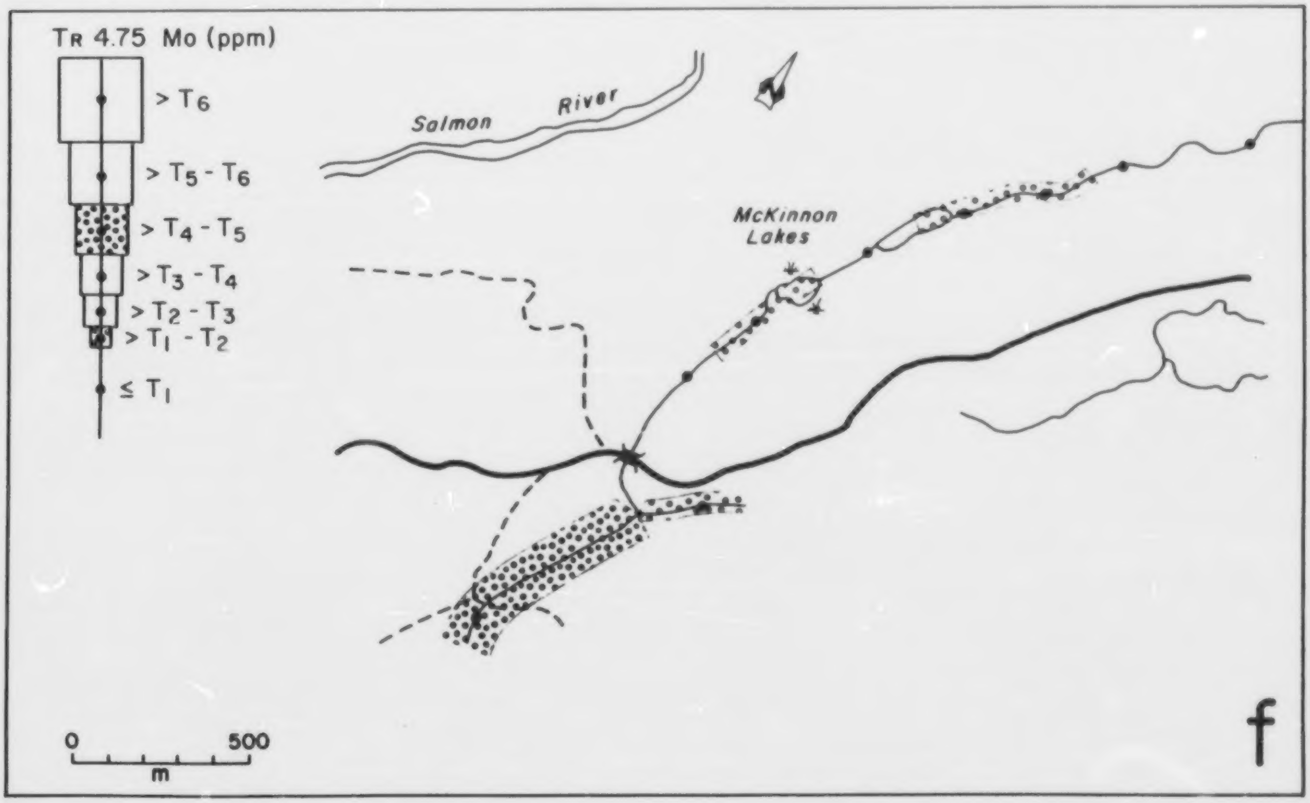


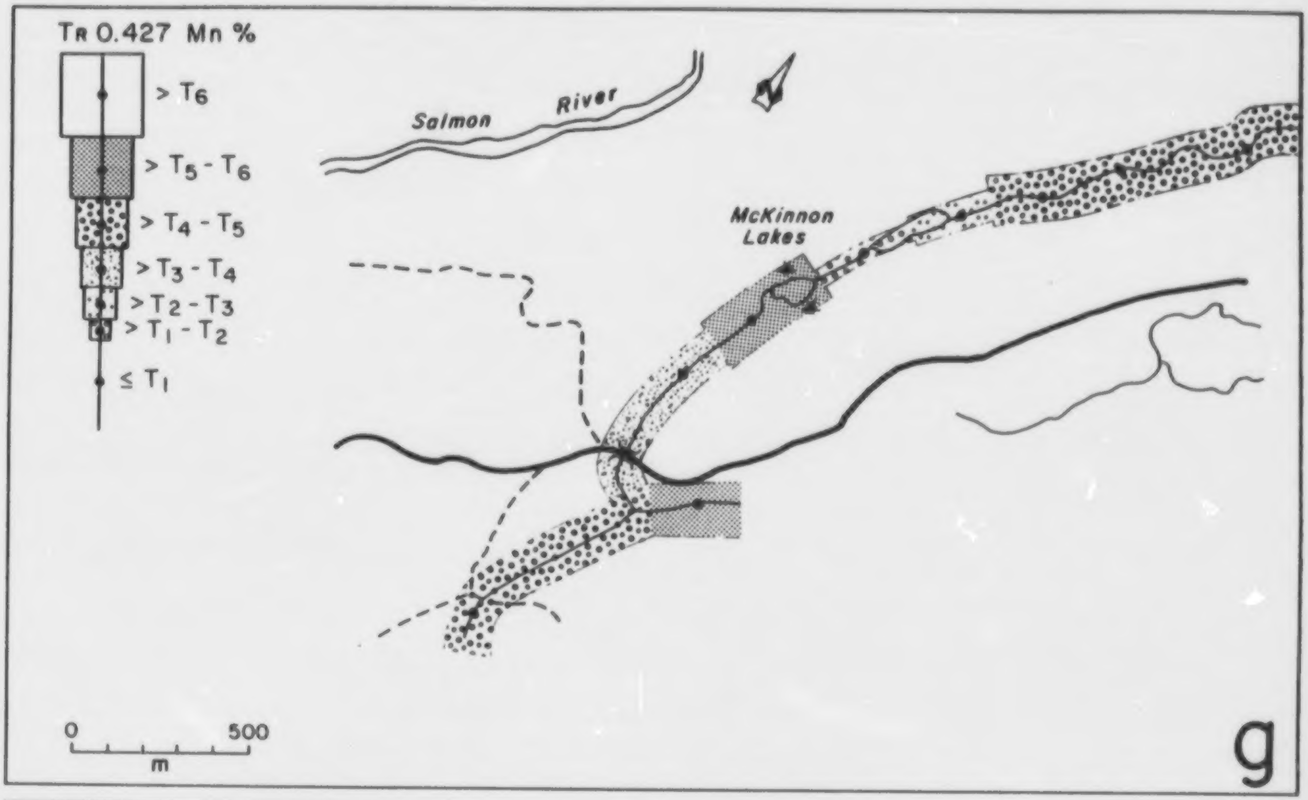
TR 18.47 Cu (ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
c



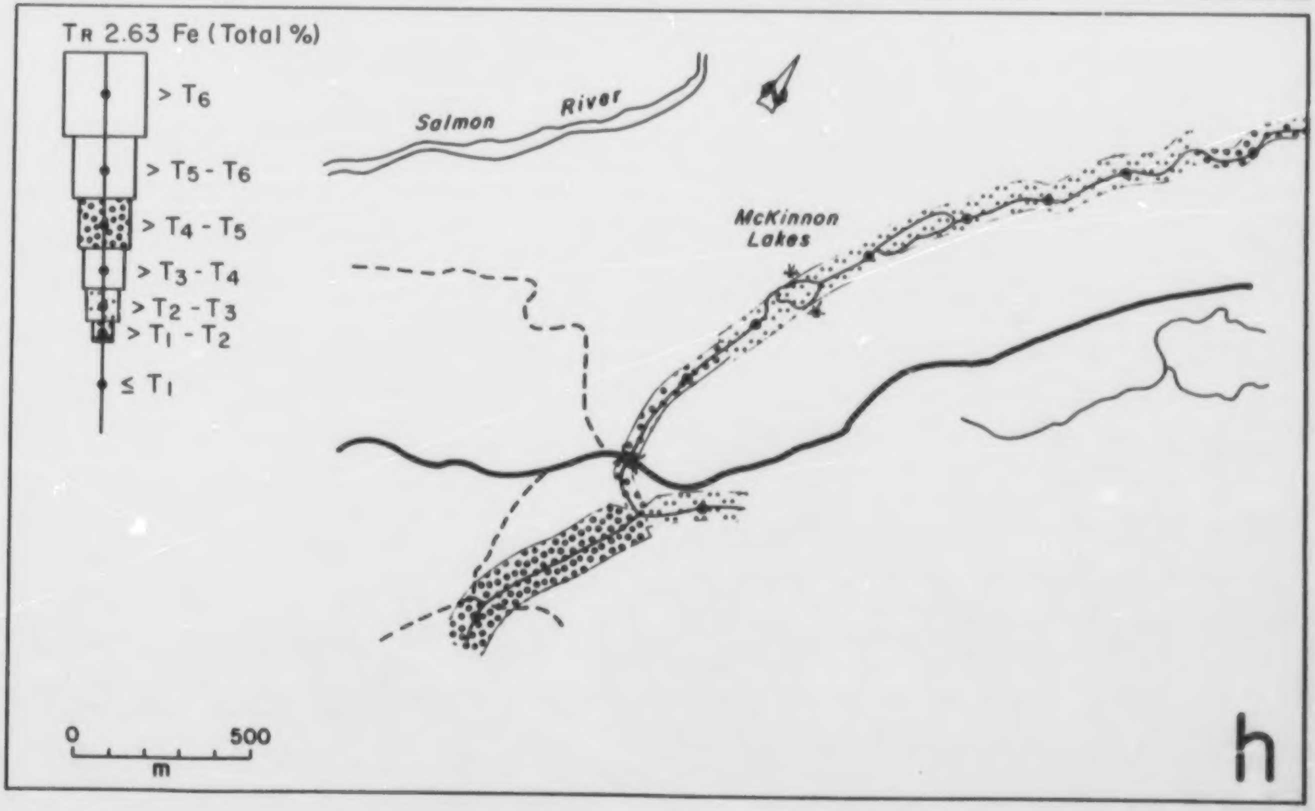
TR 0.21 Ag (ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
d


TR 15.47 As (ppm)
> $T_6$
> $T_5$ - $T_6$
> $T_4$ - $T_5$
> $T_3$ - $T_4$
> $T_2$ - $T_3$
> $T_1$ - $T_2$
≤ $T_1$
Salmon River
McKinnon Lakes
0
500
m
e

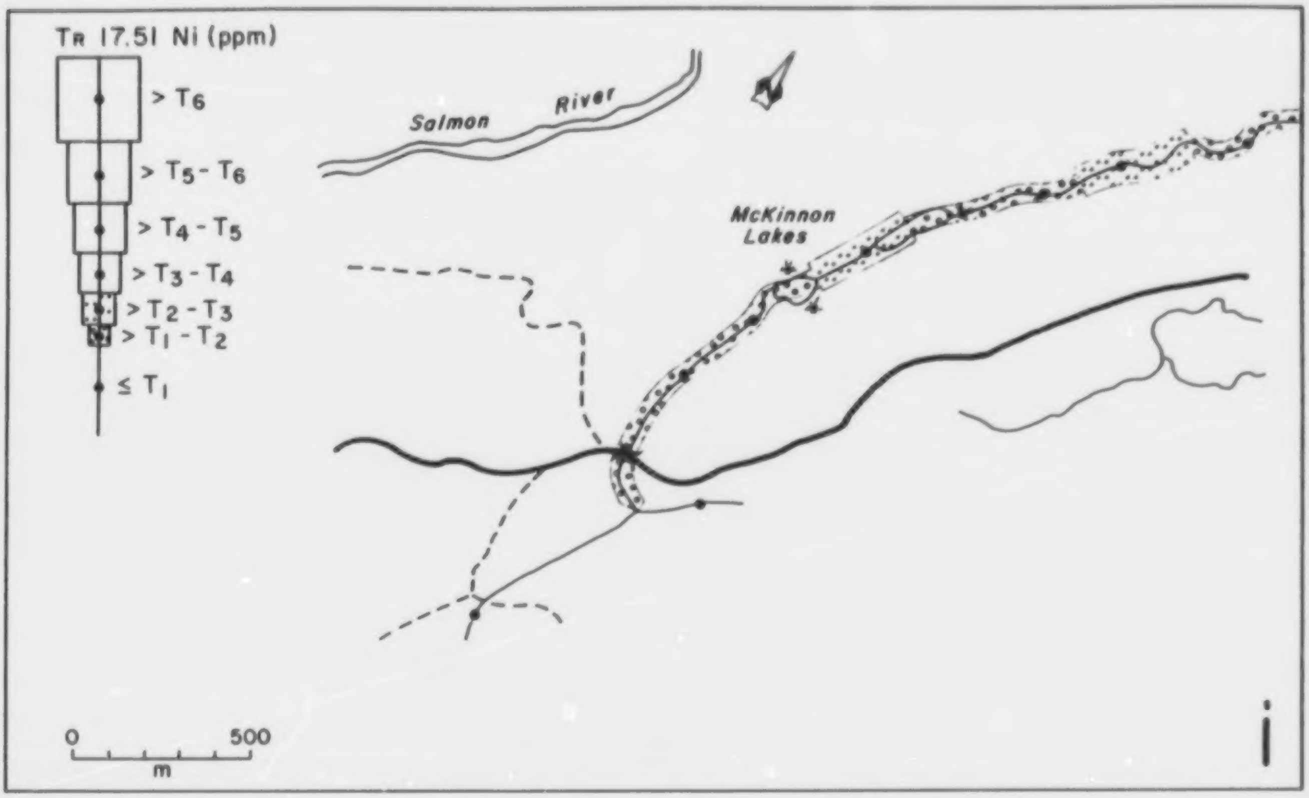

TR 4.75 Mo (ppm)
> $T_6$
> $T_5$ - $T_6$
> $T_4$ - $T_5$
> $T_3$ - $T_4$
> $T_2$ - $T_3$
> $T_1$ - $T_2$
≤ $T_1$
Salmon River
McKinnon Lakes
0
500
m
f

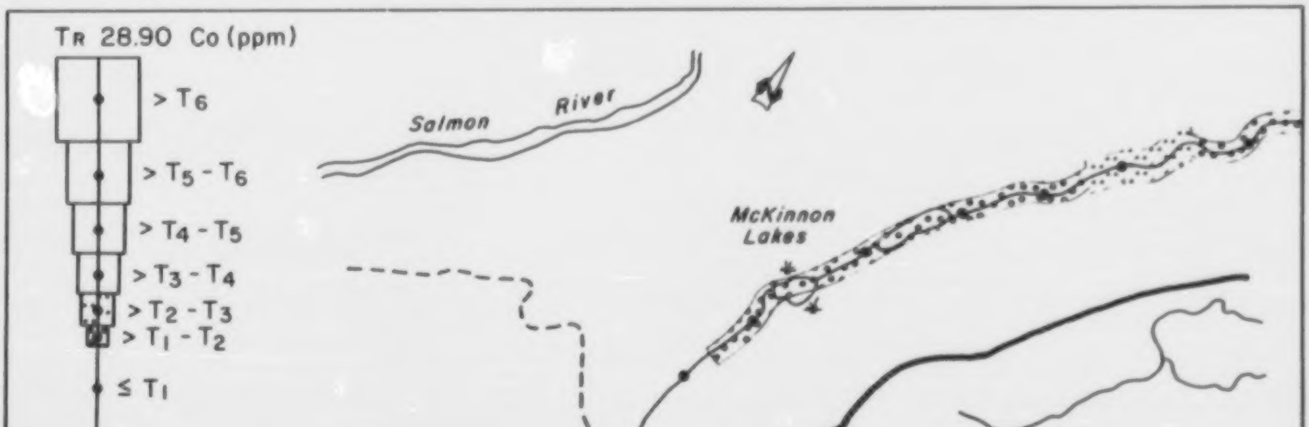


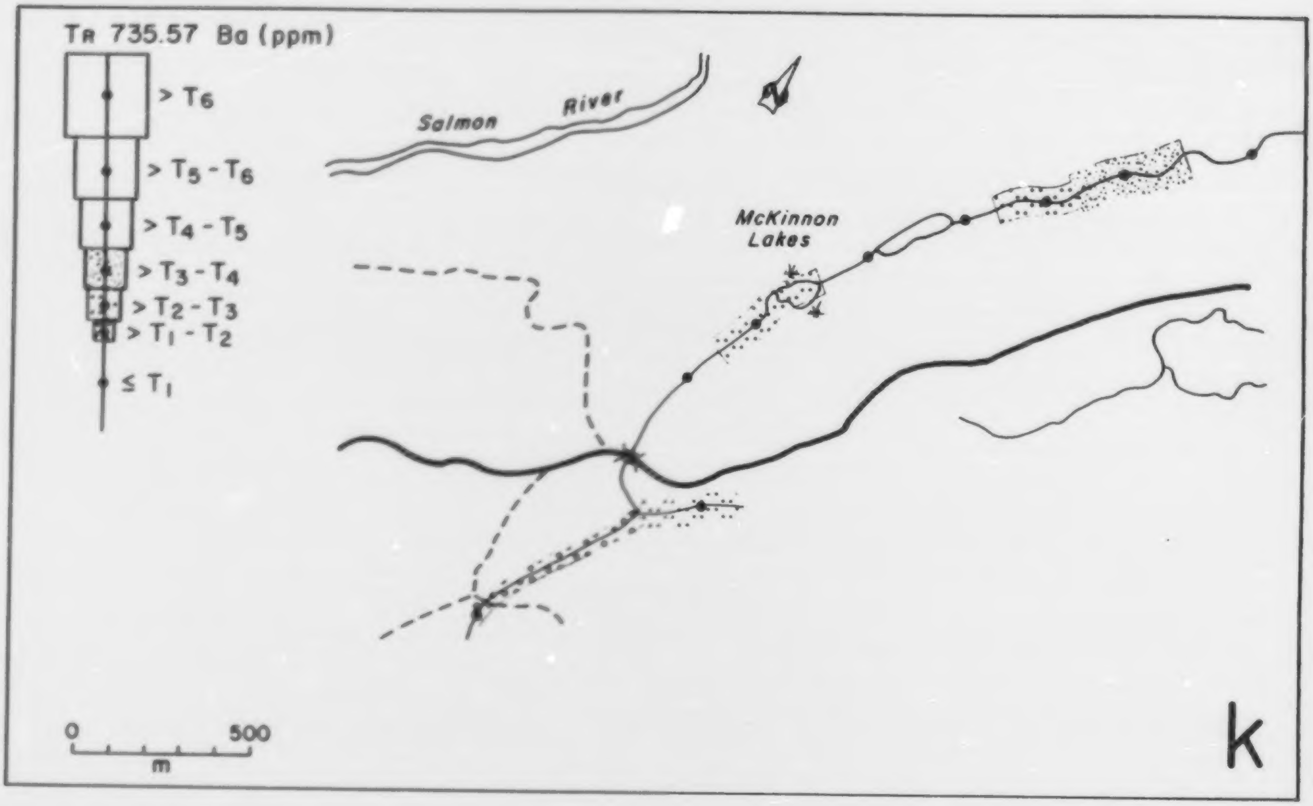
TR 0.427 Mn %
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
g



TR 2.63 Fe (Total %)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
h


TR 17.51 Ni (ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
i


TR 28.90 Co (ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
j


TR 735.57 Ba (ppm)
> T6
> T5 - T6
> T4 - T5
> T3 - T4
> T2 - T3
> T1 - T2
≤ T1
Salmon River
McKinnon Lakes
0
500
m
k

striking feature of the data is the high concentration of Pb, and to a lesser extent Zn, throughout the majority of the stream (Figs. 22a and b). All 9 samples contained ≥6 times the inspection level or "threshold" value of Pb (116 ppm). This substantially exceeds the concentrations of Pb in the 2 samples from this stream that were reported in Rogers and MacDonald (1986; 1000 and 350 ppm). As noted above, this presumably arises from the differences in size fractions between the two surveys. The southernmost sample returned a value of 1846 ppm Pb. This sample was collected upstream from the proposed ore subcrop, over rhyolite bedrock in an area where the till clasts are dominated by rhyolite (generally ≥90%). The possible origin(s) for this high value will be discussed later. Concentrations of Zn are slightly elevated (1-2T) above the projected ore zone, however, in contrast to the Pb data there is a significant increase in Zn values over (5T) and downstream (3-6T) from the deposit. Cu is only slightly elevated (1T; Fig. 22c) directly over and immediately downstream (approximately 500m) from the ore. The relative concentrations of Pb, Zn and Cu in the stream sediments closely reflects the geochemistry of the Yava ore as outlined in section 2.4. Ag concentrations are elevated over the entire stream (1->6T; Fig. 22d). However, the lowest values of Ag occur in the samples directly over immediately downstream from the deposit, whereas the highest values (>6T) occur over the rhyolite dominated terrane and 1-1.5km downstream from the subcropping ore. As is slightly elevated (1T; Fig. 22e) above and up to >1km downstream from the deposit. Curiously the highest As values occur in a sample taken 1.5 km downstream. High values of Mo (1T; Fig. 22f) occur sporadically throughout the stream with the highest value in the sample over the rhyolite. This is consistent with the inherent enrichment in Mo that is observed in many rhyolite/granite complexes. Virtually all of the samples contain high values of Fe and Mn (Figs. 22g and 22h). It is well documented that both of these elements are scavengers for many trace elements (Hawkes and Webb, 1962; Levinson, 1974). Zn, Co, Ni, As and Pb are susceptible to this scavenging and often forms "false" hydromorphic anomalies in areas with elevated levels of Fe and Mn (Rogers unpubl. data). Some of the elevated trace element values noted above may result from hydromorphic scavenging.

Moderately elevated levels of Ni, Co and Ba (1-3T) are also present in the stream sediments from this survey (Figs. 22i to k). Ni values increase substantially below the ore zone which may reflect an increase in Ni-bearing heavy minerals (possibly ilmenite, magnetite or chromite) which, as discussed above in section 2.3, are concentrated in the ore-bearing channel sandstones. Similarly, Co-enrichment (Fig. 22j) in samples taken downstream from the deposit may reflect an increase in Co-bearing heavy minerals in the -230 (-62.5 μm) fraction. Conversely, the high levels in samples upstream from the road necessitate an alternate explanation. The lowest concentrations of Ba (<1T) occur in samples taken directly over and 750 and 100m downstream from the east zone subcrop (Fig. 22k). High values of Ba (1-2T) occur both upstream and downstream from the ore zone with the highest value in a sample taken approximately 1.5km away. If the Ba concentrations were from discrete grains of barite from the ore the highest values would probably be much more proximal to the ore, not be found on the downstream side of two small lakes and intervening swampy terrain. Therefore the Ba anomalies are presumably due to "exchangeable" or adsorption processes.

It is clear from the above data that a regional stream sediment survey that samples all first-, second- and third-order streams on a 2km spacing would undoubtedly "find" any other "Yava deposits" that are traversed by a drainage system. This corroborates the results of orientation studies conducted by Rogers and MacDonald (1984) elsewhere on Cape Breton Island. Subsequent detailed sampling of anomalous drainage system(s) would provide a complete multi-element geochemical profile that could be compared with the data from this study. Our data indicates that the best elements for exploration purposes are undoubtedly Pb, Zn and Ag. Both Ni and Co show moderate, but consistent anomalies downstream from the deposit and may therefore also be suitable "pathfinder" elements. Other elements display weakly anomalous or sporadic behaviour (e.g. Cu, As, Mo, Ba) and are best used to help define the exact mineralized source. The presence of Pb, Ag and to a lesser degree Zn anomalies upstream from the mineralized source is problematical. The significance of these anomalies will be discussed in the next section.

### 9.4.2 Heavy mineral separates from -60+230 (-250+62.5 μm) fraction

The non-magnetic heavy mineral separates from the -60+230 mesh (-250+62.5 μm) fraction of the stream sediments were digested and analysed at Chemex Laboratories Ltd. of North Vancouver, British Columbia. Analytical procedures were the same as for the heavy mineral separates for till matrix and are outlined in section 9.1.2. Analytical results for the nine samples are given in Table 9a of Appendix A. The data was subsequently weighted according to the procedure of Toverud (1982) and is given in Table 9b. Analytical results for standards, analytical sample splits and field duplicates are the same as for the -60+230 mesh (-250+62.5 μm) heavy mineral till matrix data set and are given in Tables 5c - 5g. Regional stream sediment heavy mineral data from Mills (1989) was employed to establish inspection levels or "threshold" values as outlined above. It should be stressed that the data reported by Mills (1989) has not been weighted. The resulting inspection levels include: Ag(3.3 ppm); Ba(9579 ppm); Cd(7.9 ppm); Co(76.3 ppm); Cr(1854 ppm); Fe(53.8 %); Mo(34.5 ppm); Na(43.2%); Ni(59 ppm); Ti(10.6%); Zn(3026 ppm) and Zr(20435 ppm). When the unweighted data from our survey was compared with these values, only a few elements showed significant enrichment in contrast to the -230 (-62.5 μm) fraction stream silts described above. For example, Cd is elevated in all samples except #90-008, Zn was only enriched in sample #90-001 and well downstream from the deposit at #90-007. Interestingly, sample #90-007 was also the only sample to contain elevated Ag (3.5 ppm). Unfortunately, no data was available from Mills (1989) for either Pb or Cu and it was not possible to evaluate these elements. What could the source for the obvious discrepancy between the -230 (-62.5 μm) silt and clay and -60+230 (-250+62.5 μm) heavy mineral fractions be? It is possible that most of the elevated values in the -230 (-62.5 μm) fraction were from hydromorphic versus clastic sources. However, the strong similarity in patterns shown by the -230 till fraction and -60+230 heavy mineral till fractions (see above discussion), argues against a strictly hydromorphic origin for the observed distribution. The second possible explanation is that the analytical results obtained by Mills (1989) were much higher or more "total" than the "partial" results by acid digestion or li-metaborate fusion (described in section 9.1.2). Also there appears to be some problems with the data of Mills

(1989). For example the mean concentration of Fe for the non-magnetic fraction is 27% which appears excessive considering all, or most of, the magnetite was removed. Also values of Na and Ti are conspicuously high. In light of the above points it was decided that the unweighted be examined without the benefit of mathematically-derived inspection levels.

The distribution of Pb and Cu in the heavy mineral concentrates explicitly defines the location of the subcrop of the east ore zone and, therefore, resembles the -230 (-62.5 μm) fraction analytical data. The high concentration of Pb in sample #90-009, which overlies rhyolite bedrock, argues against a hydromorphic origin for the high values in the -230 mesh (-62.5 μm) fraction. A possible source for this Pb enrichment is the presence of bedrock vein-type Pb±Ba mineralization as discussed in the general geology section. Elevated levels of Cd over the sedimentary rocks and not over the rhyolites, is consistent with the till data. Interestingly, the highest concentrations of Zn and Ag is in sample #90-007 which is the sample taken furthest downstream from the deposit. This sample was collected beyond, but "down-ice" from the ribbon-shaped Zn anomaly in the -230 (-62.5 μm) fraction of the grid till samples. Attention is also brought to the high Ag values in the -60+230 mesh (-250+62.5 μm) heavy mineral till samples at the northeastern side of the grid. It is possible that these enrichments in Zn and Ag may result from the intersection of the stream with either dispersed glacial material or bedrock Zn-Ag sources or alternately may result from the winnowing processes in the stream.

The highest concentrations of Sr and V occur over the rhyolite whereas the highest Ti and Zr concentrations are occur in stream sediment heavy minerals over sedimentary rocks. These features are consistent with the heavy mineral till data.

It is apparent from the above data that a heavy mineral stream sediment survey that employed a 2 km sample spacing on all first, second and third order streams, would "find" any glaciated "Yava-type" mineral deposits in similar geomorphological regions to the study area. At least on the basis of the Cd and Zn concentrations. There is no way to statistically evaluate whether or not this same survey would delineate "anomalous" Pb and Cu, as no regional data is available. The high concentration of Ag, Cd, Zn and Zr in sample #90-007 indicates a "downstream" source for heavy minerals. This source could be from dispersed till or discrete bedrock source(s).

## 10 SUMMARY AND DISCUSSION

The Yava Lead Deposit is essentially a monomineralic deposit consisting of galena-cemented grey sandstones in the basal 17 metres of the Silver Mine Formation of the Glengarry Half Graben (Sangster and Vaillancourt, 1990). Sphalerite mineralization is associated with, but generally removed from the Yava Pb mineralization (Sangster and Vaillancourt, 1990). The Yava Deposit was glaciated by a series of northeast-trending ice flows that first deposited a highly-compacted clay-rich till sheet that often forms the cores of drumlins in the study area. Secondly, a thin sandy ground moraine was deposited across the entire area. Our overburden drilling program to the northeast of the subcrop of the East Zone ore body indicates that mineralized boulders from the ore zone have been dispersed for at least 750 m to the northeast in both the lower and upper till sheets. Several samples that were analysed contained both ore-grade Pb ($\geq$5%) and Zn ($\geq$2.5%). The grid till clast study indicates a local source for clasts and possibly a portion of the matrix.

Our work indicates the Yava deposit has a robust geochemical signature that is detectable in several geochemical media. The results of this study are summarized in Table 10. It is apparent that most media display strong enrichments in both Pb and Zn near the subcrop of the east zone ore horizon. However the geochemical response of Cu, Cd, Ag, Ba, Fe, As and Sb varies substantially between sample media. Each medium may show enrichment/depletion in one or more of these elements and, depending upon the medium, the distribution may or may not reflect the location of the subcropping ore zone. The following section discusses the response of each sample media.

The Yava deposit has a pronounced stream sediment geochemical signature that was delineated by both the -230 mesh (-62.5$\mu$m) fraction and -60+230 mesh (-250+62.5 $\mu$m) heavy mineral separates. The stream sediments are most notably enriched in Pb and to a lesser extent Zn (Table 10). A regional survey employing a 2 km spacing would undoubtedly "find" any Yava-type deposits that are crossed by a good drainage system. Further detailed work would possibly outline slight enrichments in Ag, Cu, and possibly Ni, Co and Ba as noted in this study. The very high Pb values in both the -230 mesh (-62.5$\mu$m) and -60+230 mesh (-250+62.5 $\mu$m) heavy mineral separates from samples upstream from the subcrop of the ore zone presumably reflect rhyolite-hosted vein-type Pb$\pm$Ba mineralization, similar to the original Silver Mine discovery showing(s).

The multi-media data from the 2 km$^2$ grid indicated the Yava deposit has a pronounced geochemical signature or fingerprint that is readily detected in till, biogeochemical and organic humus sample media. A complete synthesis and discussion of the implications of this information is beyond the scope of this report. However, the following is a summary and discussion of the more important findings.

The robust geochemical signature (Pb and Zn) of the Yava deposit (east zone) is detectible in: the -230 mesh (-62.5$\mu$m) fraction of till samples; the heavy mineral separates from the -60+230 mesh (-250+62.5 $\mu$m) fraction of till samples and the ashed Balsam Fir twigs. All

TABLE 10. Summary of geochemical response for various geochemical media from the Yava deposit.

| | Pb | Zn | Cu | Cd | Ag | Ba | Fe | As | Sb |
|---|---|---|---|---|---|---|---|---|---|
| Stream sediment (-230) | * | * | * | | • | • | • | • | |
| Stream sediment (HM) | * | * | • | | • | • | | | |
| Till matrix (-230) | * | * | | | • | | | * | |
| Till matrix (HM) | * | * | * | * | * | * | | | |
| Ashed Balsam Fir | * | • | | | * | | * | • | • |
| Humus (-80) | • | • | | | * | | | | |

* elevated values - delineate location of ore subcrop.
• elevated values - do not correspond to ore zone.

three sample media define the approximate location of the subcrop of the east zone of the Yava Deposit. The -80 mesh (-177 $\mu$m) fraction of the organic humus ("A" horizon) also defines strong enrichments in both Pb and Zn. However, the position of these enriched zones appears to be displaced from the subcropping ore zone. In fact, samples with the highest Pb and Zn values are frequently located in low swampy areas near the stream that crosses the sample grid. An exception is the distribution of Ag in humus samples where the subcrop of the ore zone is successfully delineated. The implications of these observations is that the geochemistry of till collected below the oxidized zone (silt-clay and heavy minerals) and Balsam Fir is less affected by hydromorphic processes than is humus. Consequently, the humus results for most elements (except Ag) more closely reflect those of Geisler (1963).

Several other elements display enrichment near the subcrop of the Yava Deposit's east zone. These include: Cu, Cd and to a certain degree Ba in till (heavy mineral); Ag in till (heavy mineral), Balsam Fir and humus; and Fe in Balsam Fir. These enrichments are consistent with the observed enrichments of these same elements in the lithogeochemistry of the ore, as noted above.

An interesting feature is the north-trending "anomalies" for Sb and As in the Balsam Fir data. At present there is no known "bedrock" explanation for the distribution of Sb and As in Balsam Fir samples. It is possible that this sample medium is tapping a deep-seated basement feature (structure ?) although it is impossible to resolve this issue without additional work.

The lack of a pronounced Ba-enrichment in the Balsam Fir near the east zone ore subcrop contradicts the findings of Fortescue and Hornbrook (1969). It is possible that some precipitation of Ba as BaCl, resulting from the use of HCl in the sample digestion, could explain the lack of biogeochemical response. Conversely, the study of Fortescue and

Hornbrook was located over the main zone, approximately 1.5 km west of the study area. We have analysed several samples from the highly compacted lower till sheet at the west zone decline. Most heavy mineral separates yielded Ba values from 10 000 to 281 000 ppm when prepared with a Li-metaborate fusion (Fig 16a). These values are significantly higher than any of the samples located on the grid. Therefore the lack of biogeochemical response in our survey could reflect an overall depletion in Ba in the east zone ore horizon.

It is suggested that a Li-metaborate fusion, similar to that used for the heavy mineral concentrates in this survey, be employed whenever possible. This could substantially increase the levels of Ba and Ti and to a lesser extent Al, Ca, Fe, Mg, Mn, and Zr. By eliminating both precipitation and solubility problems this fusion technique should also improve the precision of these elements. Better Fe and Mn data is of particular importance for the -230 mesh (-62.5$\mu$m) fractions of tills and stream sediments and the -80 mesh (-177 $\mu$m) humus samples. In these media Fe and Mn "scavenging" is considered to be important in controlling the distribution of many trace elements.

An integral component of a detailed geochemical follow-up study is the evaluation of the relative efficiency and cost effectiveness of the various geochemical media used in the study. A summary of the approximate sampling time and costs for both sample preparation and analysis are given in Table 11. The most efficient sampling media are Balsam Fir and humus followed by stream sediments and tills with sampling times of up to 60 minutes. The most cost effective sample preparation technique is for humus where the sample is simply dried and sieved. Sieving the -230 mesh (silt and clay) fraction from both tills and stream sediments is the next expensive technique ($10.00 ea.) followed by drying, removing needles and ashing of Balsam Fir ($15.00 ea.). By far the most expensive technique is the sieving, heavy liquid separation, washing in acetone, air drying and magnetic separation of the heavy mineral separates from both the tills and stream sediments ($25.00 ea.). Note the sieving for the heavy mineral separates is less expensive than for the silt and clay fraction because they are done at the same time. Multi-element geochemical analysis by the ICP technique using an Aqua-Regia (LeFort) digestion is the most cost-effective method for analysis ($4.50-8.00 ea.) and is virtually the same for all sample media. The chief draw-back of this method is the observed problem with Ba precipitation and poor dissolution of phases containing Ti and to a lesser extent Fe, Mg, Mn and Ca. The best way to nullify these effects is to use a Li-metaborate fusion followed by ICP-AES analysis. The analytical method used for the heavy minerals was by far the most costly. However, this procedure involved: 1) a preliminary multi-acid dissolution followed by ICP-AES analysis; 2) additional dissolution and re-analysis by ICP-AES for samples with elemental concentrations that exceeded upper detection limits; 3) Li-metaborate fusion followed by dissolution of glass beads in Hydrofluoric acid and analysis by ICP-AES; 4) additional dissolution and re-analysis by ICP-AES for all samples with elemental concentrations that exceeded upper detection limits. The cost for this complex procedure was $25.00 per sample. By avoiding the first 2 steps this cost could be significantly reduced.

Table 11. Summary of sampling times, sample preparation and analytical costs for each sample media.

| **Sample medium** | **Approx. sampling time (in min.)** | **Sample preparation cost (Minerals Engineering Centre)** | **Analytical Cost** |
|---|---|---|---|
| Stream sediment (-230) | 15-45 | - sieving $ 8.00<br>- homogenizing $ 2.00<br>Total $10.00 | ICP - Bondar-Clegg - Aqua Regia $8.00 |
| Stream sediment heavy mineral | | - sieving $ 5.00<br>- H.L. separation $15.00<br>- mag. separation $ 3.00<br>Total $23.00 | ICP - Chemex labs. - combined multi-acid digestion - ICP and Li- metaborite fusion - ICP - also redilute for high values $25.00 |
| Till matrix (-230) | 30-60 | - sieving $ 8.00<br>- homogenizing $ 2.00<br>Total $10.00 | ICP - Bondar-Clegg - Aqua Regia $8.00 |
| Till matrix heavy mineral | | - sieving $ 5.00<br>- H.L. separation $15.00<br>- mag. separation $ 3.00<br>Total $23.00 | ICP - Chemex labs. - combined multi-acid digestion - ICP and Li- metaborite fusion - ICP - also redilute for high values $25.00 |
| Balsam Fir | 5-10 | - drying and removing needles $ 5.00<br>- ashing (24 hrs) $10.00<br>Total $15.00 | ICP - ACME Analytical-Aqua Regia $4.50 |
| Humus (-80) | 5-10 | - drying and sieving $ 2.00 | ICP - Bondar Clegg - Aqua Regia $8.00 |

## 11 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

Our work demonstrates that several exploration geochemical techniques can be employed to find sandstone-hosted galena±sphalerite deposits (e.g. Yava) within the Glengarry Half Graben or Loch Lomond Basin. Geochemical media that can be employed in future exploration programmes include: -230 mesh (-62.5μm) and/or -60+230 mesh (-250+62.5 μm) non-magnetic heavy mineral separates from stream sediments taken at 2 km intervals on 1st°, 2nd° or 3rd° streams; -230 mesh (-62.5μm) and/or -60+230 mesh (-250+62.5 μm) non-magnetic heavy mineral separates from unweathered tills taken at 500 to 750 m grid spacing; ashed Balsam Fir twigs and branches (5-7 years growth) taken at 500 to 750 m grid spacing.

The -80 mesh (-177 μm) fraction from organic humus (i.e. "A" soil horizon) delineated enrichments in both Pb and Zn. Although, these enriched zones were displaced from the subcropping ore zone. The Pb- and Zn-enriched zones in both the tills and Balsam Fir were not displaced, therefore, it appears that the humus samples were more susceptible to hydromorphic dispersion and should not be included in future exploration programmes.

From the perspective of cost-effectiveness, the biogeochemical sampling of Balsam Fir twigs is the best method for geochemical exploration for Yava-type deposits in the study area. Biogeochemical sampling can be completed quickly, individual samples are rather bulky but lightweight and sample preparation procedures are relatively uncomplicated and cost-effective and do not involve numerous steps where the sample could become contaminated. It is suggested that future surveys should collect more Balsam Fir twigs than were taken in our survey. This will ensure enough material for supplementary analysis if analytical problems, similar to those of this survey, should be encountered.

The chief disadvantage with biogeochemical surveys is the deficiency of information regarding the underlying till. A sound understanding of the glacial geology is of paramount importance when interpreting the observed geochemical signatures. For example the identification of till clasts yields insight into till provenance and ice-flow directions and dispersion distances of individual till sheets. The main drawback with till sampling is that it is both time-consuming and it employs costly sample preparation procedures.

We recommend that a composite survey is the best method for discovering new "Yava-type" deposits in eastern Cape Breton Island. The first step is to sample all of the 1st°, 2nd° and 3rd° streams in the survey area using a 2 km spacing. The analysis of the -230 mesh (-62.5μm) fraction of collected samples will pin-point any Pb or Zn anomalies. The use of heavy mineral separates from the -60+230 mesh (-250+62.5 μm) fraction of streams will not contribute substantially to the information base and can be eliminated. All "anomalous" streams should then be sampled in detail at 250 m spacing to define the point where the anomalous elemental concentrations enter the stream. Following the stream sediment survey, areas that are not properly intersected by good drainage systems and areas surrounding anomalous stream sediment samples should be grid sampled using a combination of biogeochemical and till sampling techniques. Biogeochemical sampling of Balsam Fir and/or black spruce twigs depending upon species availability should be completed on 250 m grid spacing. Till samples should be collected at regular intervals, for example 500 m grid spacing, throughout the survey areas. This will ensure sufficient information regarding the glacial geology and optimize the speed and cost-effectiveness of the survey. It is not considered to be essential that heavy minerals be separated from till samples as the -230 mesh (-62.5μm) silt and clay fraction adequately defined the location of the subcrop of the east zone ore body.

All multi-media samples can be analysed by a standard ICP-AES, multi-element analytical package at a commercial laboratory. This analytical technique typically contains virtually all of the elements that are enriched in the Yava Deposit when compared to the unmineralized Silver Mine Formation or the rhyolite porphyry of the Loch Lomond Pluton. This analytical technique will possibly be replaced in future as inevitable technological advances are made.

## 12 ACKNOWLEDGEMENTS

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# 14 APPENDIX A

# DATA TABLES

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY)

| MAP# | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 900 N | 1000 N | 930 N | 930 N | 970 N | 1000 N | 705 N | 750 N | 750 N | 734 N | 750 N | 784 N |
| LOCATION | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E |
| Al % | 1.411 | 2.897 | 0.999 | 1.127 | 2.542 | 1.246 | 2.094 | 1.082 | 0.822 | 0.817 | 2.011 | 1.010 |
| Fe TOT. % | 2.65 | 3.48 | 2.05 | 1.97 | 3.12 | 2.34 | 2.60 | 2.01 | 1.87 | 1.45 | 3.40 | 2.38 |
| Mn % | -0.050 | -0.050 | -0.050 | -0.050 | 0.411 | -0.050 | 0.077 | -0.050 | 0.013 | -0.050 | 0.194 | 0.089 |
| Mg % | 0.285 | 0.337 | 0.227 | 0.221 | 0.309 | 0.216 | 0.380 | 0.245 | 0.208 | 0.152 | 0.620 | 0.297 |
| Li ppm | 19 | 34 | 13 | 14 | 26 | 16 | 22 | 16 | 12 | 10 | 33 | 18 |
| Sc ppm | 2 | 3 | 2 | 2 | 4 | 2 | 3 | 1 | 2 | 1 | 3 | 3 |
| V ppm | 18 | 22 | 13 | 14 | 24 | 15 | 21 | 15 | 13 | 10 | 27 | 17 |
| Cr ppm | 18 | 25 | 12 | 13 | 26 | 14 | 22 | 14 | 11 | 9 | 25 | 14 |
| Co ppm | 13 | 15 | 11 | 11 | 14 | 10 | 12 | 8 | 9 | 7 | 18 | 12 |
| Ni ppm | 24 | 26 | 17 | 16 | 22 | 16 | 25 | 15 | 13 | 10 | 37 | 19 |
| Cu ppm | 18 | 18 | 19 | 20 | 17 | 16 | 12 | 10 | 17 | 11 | 13 | 15 |
| Zn ppm | 174 | 153 | 103 | 83 | 118 | 102 | 142 | 120 | 133 | 107 | 216 | 203 |
| As ppm | 18 | 16 | 14 | 16 | 17 | 19 | 10 | 12 | 25 | 22 | 10 | 23 |
| Sr ppm | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 5 | 4 |
| Y ppm | 10 | 7 | 6 | 5 | 9 | 6 | 7 | 5 | 7 | 4 | 9 | 13 |
| Zr ppm | 5 | 9 | 7 | 6 | 5 | 4 | 5 | 5 | 7 | 4 | 8 | 4 |
| Ag ppm | -0.5 | 1.3 | -0.5 | -0.5 | 1.3 | -0.5 | 0.6 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 20 | 26 | 12 | 13 | 32 | 11 | 40 | 12 | 17 | 8 | 65 | 28 |
| La ppm | 18 | 19 | 17 | 16 | 20 | 14 | 18 | 15 | 18 | 12 | 23 | 19 |
| Ce ppm | 78 | 57 | 49 | 48 | 82 | 48 | 77 | 47 | 53 | 37 | 79 | 66 |
| Pb ppm | 114 | 445 | 105 | 76 | 85 | 71 | 44 | 45 | 97 | 99 | 70 | 148 |

Table 4a. Analytical data for the -230 mesh fraction of till samples from the Yava grid.

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY)

| MAP# | 15 | 16 | 17 | 18 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 720 N | 480 N | 475 N | 500 N | 534 N | 500 N | 485 N | 500 N | 250 N | 270 N | 250 N | 250 N |
| LOCATION | 1400 E | 500 W | 250 W | 0 | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E |
| Al % | 0.755 | 1.216 | 1.018 | 0.986 | 1.111 | 0.982 | 1.003 | 0.850 | 1.777 | 1.139 | 0.765 | 0.841 |
| Fe TOT. % | 1.79 | 2.67 | 2.32 | 2.29 | 1.93 | 1.95 | 1.62 | 1.83 | 2.97 | 3.48 | 2.49 | 2.62 |
| Mn % | 0.057 | 0.065 | 0.082 | 0.115 | 0.004 | 0.056 | -0.050 | -0.050 | 0.052 | 0.098 | 0.106 | 0.112 |
| Mg % | 0.215 | 0.325 | 0.254 | 0.544 | 0.279 | 0.276 | 0.250 | 0.229 | 0.524 | 0.370 | 0.262 | 0.230 |
| Li ppm | 12 | 18 | 12 | 18 | 19 | 16 | 16 | 12 | 25 | 16 | 13 | 11 |
| Sc ppm | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 5 | 3 | 2 | 3 |
| V ppm | 12 | 18 | 14 | 16 | 15 | 14 | 13 | 12 | 22 | 17 | 13 | 13 |
| Cr ppm | 11 | 16 | 12 | 14 | 15 | 13 | 13 | 11 | 23 | 14 | 11 | 10 |
| Co ppm | 9 | 13 | 11 | 12 | 11 | 8 | 6 | 8 | 12 | 14 | 12 | 10 |
| Ni ppm | 12 | 21 | 16 | 21 | 16 | 18 | 13 | 14 | 24 | 19 | 17 | 13 |
| Cu ppm | 9 | 23 | 16 | 19 | 7 | 13 | 8 | 13 | 22 | 21 | 18 | 15 |
| Zn ppm | 172 | 186 | 212 | 455 | 173 | 379 | 128 | 252 | 170 | 449 | 459 | 691 |
| As ppm | 18 | 15 | 33 | 18 | 13 | 16 | 13 | 22 | 9 | 20 | 22 | 24 |
| Sr ppm | 3 | 5 | 3 | 29 | 3 | 4 | 3 | 4 | 3 | 3 | 5 | 3 |
| Y ppm | 5 | 10 | 6 | 10 | 6 | 10 | 4 | 5 | 8 | 19 | 17 | 9 |
| Zr ppm | 5 | 8 | 6 | 10 | 5 | 6 | 3 | 4 | 11 | 10 | 8 | 6 |
| Ag ppm | -0.5 | -0.5 | -0.5 | 0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 11 | 26 | 14 | 254 | 16 | 57 | 10 | 10 | 19 | 17 | 100 | 18 |
| La ppm | 17 | 18 | 18 | 15 | 19 | 21 | 16 | 17 | 23 | 24 | 25 | 19 |
| Ce ppm | 50 | 57 | 54 | 47 | 54 | 57 | 43 | 51 | 72 | 56 | 64 | 48 |
| Pb ppm | 223 | 150 | 255 | 530 | 62 | 309 | 85 | 322 | 81 | 659 | 320 | 1395 |

Table 4a. Analytical data for the -230 mesh fraction of till samples from the Yava grid.

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY)

| MAP# | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 N | 250 N | 300 N | 250 N | 0 | 0 | 0 | 0 | 0 | 100 N | 65 N | 0 |
| LOCATION | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 900 E | 1175 E |
| Al % | 1.116 | 1.456 | 1.047 | 1.013 | 1.517 | 0.855 | 1.100 | 1.201 | 0.576 | 1.326 | 2.665 | 2.078 |
| Fe TOT. % | 2.59 | 3.71 | 2.60 | 2.44 | 3.15 | 1.43 | 1.78 | 2.25 | 1.61 | 2.20 | 2.41 | 1.85 |
| Mn % | 0.063 | 0.189 | 0.091 | 0.246 | 0.250 | 0.152 | 0.214 | 0.144 | 0.099 | 0.079 | 0.193 | 0.060 |
| Mg % | 0.335 | 0.333 | 0.251 | 0.214 | 0.343 | 0.147 | 0.210 | 0.380 | 0.121 | 0.335 | 0.211 | 0.337 |
| Li ppm | 15 | 16 | 12 | 10 | 19 | 8 | 10 | 17 | 6 | 14 | 16 | 21 |
| Sc ppm | 2 | 5 | 4 | 2 | 4 | 2 | 2 | 3 | 1 | 3 | 4 | 2 |
| V ppm | 18 | 19 | 14 | 12 | 18 | 10 | 11 | 16 | 8 | 17 | 16 | 15 |
| Cr ppm | 15 | 15 | 11 | 12 | 17 | 8 | 9 | 14 | 6 | 13 | 16 | 15 |
| Co ppm | 9 | 13 | 8 | 10 | 12 | 7 | 8 | 11 | 6 | 8 | 9 | 10 |
| Ni ppm | 17 | 19 | 16 | 14 | 27 | 10 | 13 | 21 | 10 | 18 | 18 | 37 |
| Cu ppm | 11 | 38 | 17 | 13 | 22 | 14 | 24 | 19 | 12 | 20 | 26 | 16 |
| Zn ppm | 655 | 1026 | 596 | 763 | 793 | 200 | 468 | 520 | 398 | 521 | 494 | 259 |
| As ppm | 14 | 35 | 23 | 30 | 38 | 12 | 18 | 31 | 26 | 10 | 20 | -5 |
| Sr ppm | 5 | 5 | 4 | 4 | 6 | 5 | 5 | 5 | 4 | 7 | 4 | 4 |
| Y ppm | 6 | 8 | 5 | 6 | 8 | 6 | 5 | 18 | 6 | 25 | 7 | 3 |
| Zr ppm | 6 | 6 | 8 | 6 | 8 | 4 | 5 | 8 | 6 | 11 | 6 | 12 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | 0.6 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 25 | 20 | 14 | 15 | 123 | 16 | 35 | 13 | 11 | 35 | 35 | 28 |
| La ppm | 19 | 22 | 18 | 17 | 20 | 13 | 13 | 21 | 13 | 27 | 14 | 9 |
| Ce ppm | 47 | 72 | 48 | 51 | 65 | 49 | 45 | 48 | 39 | 54 | 56 | 34 |
| Pb ppm | 677 | 1952 | 1377 | 3401 | 6758 | 1136 | 2051 | 6470 | 2981 | 3523 | 2175 | 397 |

Table 4a. Analytical data for the -230 mesh fraction of till samples from the Yava grid.

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY)

| MAP# | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 S | 250 S | 230 S | 250 S | 250 S | 250 S | 250 S | 250 S | 500 S | 508 S | 508 S | 500 S |
| LOCATION | 500 W | 250 W | 0 | 250 E | 485 E | 650 E | 900 E | 1175 E | 500 W | 283 W | 12 W | 250 E |
| Al % | 1.139 | 0.476 | 1.302 | 2.795 | 3.456 | 1.099 | 2.276 | 0.826 | 0.902 | 0.709 | 2.559 | 2.925 |
| Fe TOT. % | 1.64 | 0.76 | 0.96 | 0.94 | 1.15 | 0.62 | 0.82 | 0.52 | 1.09 | 0.48 | 0.99 | 1.00 |
| Mn % | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 |
| Mg % | 0.237 | 0.095 | 0.094 | 0.064 | 0.061 | 0.054 | -0.050 | -0.050 | 0.141 | -0.050 | 0.067 | 0.060 |
| Li ppm | 10 | 7 | 7 | 7 | 9 | 5 | 7 | 3 | 8 | 5 | 7 | 8 |
| Sc ppm | 2 | 1 | -1 | 1 | 2 | -1 | 1 | -1 | 1 | -1 | 1 | 1 |
| V ppm | 15 | 7 | 9 | 9 | 9 | 7 | 9 | 6 | 11 | 6 | 10 | 11 |
| Cr ppm | 9 | 6 | 6 | 4 | 6 | 3 | 4 | 3 | 8 | 3 | 7 | 5 |
| Co ppm | 6 | 3 | 4 | 2 | 3 | 2 | 2 | 2 | 4 | 1 | 4 | 2 |
| Ni ppm | 10 | 7 | 6 | 4 | 5 | 4 | 3 | 3 | 9 | 3 | 5 | 4 |
| Cu ppm | 7 | 10 | 8 | 7 | 7 | 6 | 16 | 3 | 11 | 5 | 6 | 6 |
| Zn ppm | 135 | 104 | 103 | 47 | 50 | 29 | 32 | 26 | 60 | 19 | 46 | 46 |
| As ppm | 9 | 15 | 10 | 9 | 16 | -5 | -5 | 10 | 14 | 11 | 6 | -5 |
| Sr ppm | 3 | 5 | 4 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 4 | 3 |
| Y ppm | 5 | 8 | 3 | 3 | 3 | 2 | 4 | 2 | 3 | 3 | 4 | 2 |
| Zr ppm | 6 | 4 | 4 | 8 | 11 | 5 | 8 | 6 | 7 | 4 | 9 | 11 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 26 | 65 | 12 | 16 | 14 | 8 | 8 | 9 | 20 | 44 | 14 | 14 |
| La ppm | 14 | 11 | 8 | 5 | 5 | 4 | 5 | 3 | 10 | 6 | 6 | 3 |
| Ce ppm | 55 | 32 | 29 | 20 | 25 | 22 | 22 | 17 | 33 | 23 | 28 | 14 |
| Pb ppm | 133 | 111 | 77 | 44 | 99 | 20 | 87 | 18 | 73 | 15 | 45 | 17 |

Table 4a. Analytical data for the -230 mesh fraction of till samples from the Yava grid.

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY)

| MAP# | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 61 | 62 |
|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 500 S | 500 S | 500 S | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S |
| LOCATION | 500 E | 1000 E | 1175 E | 500 W | 295 W | 0 | 250 E | 470 E | 1000 E | 1175 E |
| Al % | 2.073 | 0.727 | 1.326 | 1.286 | 0.159 | 1.102 | 1.482 | 0.681 | 1.267 | 0.951 |
| Fe TOT. % | 0.73 | 0.83 | 0.89 | 0.69 | 0.43 | 0.49 | 0.69 | 0.30 | 0.59 | 0.69 |
| Mn % | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 |
| Mg % | -0.050 | 0.099 | 0.093 | 0.072 | -0.050 | -0.050 | 0.095 | -0.050 | -0.050 | 0.083 |
| Li ppm | 5 | 6 | 7 | 6 | 2 | 3 | 7 | 3 | 3 | 6 |
| Sc ppm | 1 | -1 | 1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| V ppm | 8 | 9 | 9 | 7 | 5 | 5 | 8 | 4 | 8 | 7 |
| Cr ppm | 4 | 5 | 6 | 5 | 2 | 3 | 5 | 2 | 3 | 4 |
| Co ppm | 3 | 3 | 3 | 2 | 1 | 2 | 3 | -1 | 2 | 2 |
| Ni ppm | 3 | 6 | 6 | 5 | 2 | 3 | 6 | 2 | 3 | 4 |
| Cu ppm | 6 | 6 | 6 | 5 | 3 | 4 | 6 | 3 | 4 | 4 |
| Zn ppm | 27 | 46 | 41 | 29 | 18 | 17 | 34 | 14 | 20 | 22 |
| As ppm | 9 | 9 | 12 | 8 | 14 | 8 | 10 | 8 | 8 | 13 |
| Sr ppm | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 |
| Y ppm | 2 | 2 | 3 | 2 | 4 | 2 | 2 | 1 | 3 | 2 |
| Zr ppm | 8 | 5 | 6 | 4 | 6 | 6 | 6 | 6 | 6 | 3 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 10 | 15 | 27 | 12 | 77 | 9 | 12 | 7 | 12 | 11 |
| La ppm | 3 | 6 | 7 | 5 | 6 | 3 | 2 | 2 | 5 | 4 |
| Ce ppm | 18 | 21 | 30 | 24 | 22 | 14 | 19 | 12 | 23 | 14 |
| Pb ppm | 23 | 23 | 26 | 20 | 11 | 19 | 13 | 8 | 17 | 14 |

**Table 4a.** Analytical data for the -230 mesh fraction of till samples from the Yava grid.

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY) STANDARDS

| | STD 1 | STD 1 | STD 2 | STD 2 | STD 3 | STD 3 | STD 3 |
|---|---|---|---|---|---|---|---|
| Al % | 0.698 | 0.701 | 1.037 | 1.013 | 2.750 | 2.784 | 2.789 |
| Fe TOT. % | 1.63 | 1.70 | 1.68 | 1.64 | 4.71 | 4.73 | 4.81 |
| Mn % | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 | -0.050 |
| Mg % | 0.307 | 0.319 | 0.323 | 0.308 | 1.545 | 1.571 | 1.606 |
| Li ppm | 9 | 9 | 13 | 13 | 56 | 55 | 55 |
| Sc ppm | 3 | 3 | 3 | 3 | 9 | 9 | 9 |
| V ppm | 25 | 26 | 25 | 24 | 61 | 62 | 62 |
| Cr ppm | 22 | 22 | 27 | 26 | 63 | 64 | 64 |
| Co ppm | 5 | 6 | 7 | 7 | 17 | 17 | 17 |
| Ni ppm | 19 | 19 | 22 | 20 | 49 | 50 | 50 |
| Cu ppm | 16 | 18 | 24 | 24 | 83 | 81 | 82 |
| Zn ppm | 51 | 51 | 60 | 51 | 129 | 121 | 124 |
| As ppm | 15 | 12 | -5 | -5 | 28 | 26 | 25 |
| Sr ppm | 26 | 27 | 23 | 22 | 10 | 9 | 9 |
| Y ppm | 11 | 11 | 15 | 15 | 22 | 22 | 22 |
| Zr ppm | 15 | 15 | 13 | 12 | 39 | 39 | 39 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 66 | 65 | 94 | 91 | 145 | 147 | 145 |
| La ppm | 40 | 39 | 43 | 42 | 88 | 89 | 89 |
| Ce ppm | 79 | 80 | 89 | 87 | 160 | 167 | 169 |
| Pb ppm | 9 | 3 | 7 | 9 | 21 | 26 | 19 |

**Table 4b. Analytical data for standards used in the analysis of the -230 mesh fraction of till and stream sediment samples.**

YAVA GRID SURVEY 1990 -230 MESH FRACTION (SILT AND CLAY) SAMPLE SPLITS

| | SAMP | SPL | SAMP | SPL | SAMP | SPL | SAMP | SPL | SAMP | SPL | SAMP | SPL | SAMP | SPL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Al % | 1.095 | 1.158 | 1.195 | 1.027 | 0.901 | 0.844 | 1.304 | 1.348 | 1.254 | 0.163 | 1.144 | 1.158 | 0.704 | 0.726 |
| Fe TOT. % | 1.94 | 2.00 | 2.08 | 1.77 | 1.97 | 1.79 | 2.25 | 2.15 | 0.51 | 0.44 | 2.56 | 2.56 | 1.84 | 1.90 |
| Mn % | -0.050 | -0.050 | 0.058 | -0.050 | 0.138 | -0.050 | 0.081 | 0.076 | -0.050 | -0.050 | 0.104 | 0.103 | 0.094 | 0.096 |
| Mg % | 0.216 | 0.226 | 0.302 | 0.255 | 0.276 | 0.223 | 0.345 | 0.324 | -0.050 | -0.050 | 0.351 | 0.350 | 0.332 | 0.352 |
| Li ppm | 13 | 14 | 20 | 17 | 16 | 12 | 14 | 13 | 7 | 2 | 17 | 18 | 13 | 14 |
| Sc ppm | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | -1 | -1 | 4 | 4 | 2 | 2 |
| V ppm | 14 | 14 | 15 | 14 | 16 | 12 | 17 | 16 | 7 | 5 | 18 | 19 | 12 | 12 |
| Cr ppm | 13 | 13 | 15 | 14 | 13 | 11 | 13 | 13 | 4 | 2 | 15 | 15 | 10 | 10 |
| Co ppm | 10 | 11 | 12 | 9 | 9 | 7 | 8 | 8 | 1 | 1 | 10 | 9 | 10 | 10 |
| Ni ppm | 16 | 16 | 17 | 14 | 20 | 14 | 19 | 17 | 3 | 3 | 17 | 19 | 16 | 17 |
| Cu ppm | 19 | 20 | 8 | 6 | 14 | 14 | 20 | 19 | 7 | 3 | 14 | 15 | 13 | 14 |
| Zn ppm | 82 | 84 | 195 | 150 | 366 | 249 | 537 | 505 | 19 | 19 | 413 | 406 | 232 | 219 |
| As ppm | 16 | 16 | 16 | 10 | 15 | 17 | 13 | 7 | 12 | 9 | 15 | 22 | 24 | 17 |
| Sr ppm | 3 | 3 | 3 | 3 | 4 | 4 | 7 | 7 | 4 | 5 | 5 | 5 | 15 | 14 |
| Y ppm | 5 | 5 | 6 | 5 | 14 | 5 | 25 | 24 | 1 | 5 | 14 | 14 | 9 | 10 |
| Zr ppm | 6 | 6 | 5 | 5 | 8 | 4 | 11 | 11 | 2 | 6 | 7 | 7 | 6 | 7 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 12 | 13 | 17 | 15 | 113 | 10 | 35 | 35 | 14 | 74 | 18 | 19 | 196 | 190 |
| La ppm | 17 | 15 | 18 | 20 | 24 | 16 | 27 | 26 | 4 | 8 | 22 | 22 | 13 | 12 |
| Ce ppm | 50 | 46 | 53 | 54 | 55 | 46 | 53 | 55 | 21 | 24 | 63 | 62 | 40 | 42 |
| Pb ppm | 76 | 76 | 69 | 55 | 310 | 311 | 3648 | 3398 | 17 | 12 | 762 | 748 | 152 | 160 |

Table 4c. Analytical data for sample splits used in the analysis of the -230 mesh fraction of till and stream sediment samples.

## YAVA GRID SURVEY 1990 FIELD DUPLICATES

| | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Al % | 0.743 | 0.900 | 1.200 | 0.901 | 1.402 | 1.631 | 1.119 | 1.282 | 2.559 | 1.275 | 1.811 | 1.215 |
| Fe TOT. % | 1.35 | 2.38 | 2.08 | 1.97 | 3.29 | 3.00 | 1.77 | 2.72 | 0.99 | 0.82 | 4.17 | 2.96 |
| Mn % | -0.050 | 0.076 | 0.079 | 0.138 | 0.243 | 0.257 | 0.098 | 0.190 | -0.050 | -0.050 | 0.171 | 0.114 |
| Mg % | 0.172 | 0.244 | 0.329 | 0.276 | 0.350 | 0.336 | 0.283 | 0.477 | 0.067 | 0.078 | 0.545 | 0.351 |
| Li ppm | 11 | 12 | 19 | 16 | 18 | 19 | 13 | 20 | 7 | 6 | 21 | 16 |
| Sc ppm | 1 | 3 | 3 | 2 | 4 | 4 | 2 | 3 | 1 | 1 | 6 | 3 |
| V ppm | 10 | 15 | 15 | 16 | 17 | 18 | 13 | 19 | 10 | 9 | 26 | 18 |
| Cr ppm | 10 | 11 | 15 | 13 | 15 | 19 | 11 | 17 | 7 | 4 | 20 | 14 |
| Co ppm | 6 | 11 | 9 | 9 | 12 | 12 | 8 | 14 | 4 | 3 | 15 | 11 |
| Ni ppm | 11 | 14 | 21 | 20 | 25 | 28 | 19 | 23 | 5 | 4 | 26 | 21 |
| Cu ppm | 12 | 21 | 10 | 14 | 27 | 17 | 17 | 21 | 6 | 6 | 19 | 15 |
| Zn ppm | 90 | 175 | 523 | 366 | 823 | 763 | 582 | 458 | 46 | 63 | 819 | 492 |
| As ppm | 20 | 29 | 15 | 15 | 43 | 32 | 22 | 39 | 6 | 10 | 22 | 28 |
| Sr ppm | 3 | 4 | 4 | 4 | 7 | 5 | 5 | 4 | 4 | 5 | 4 | 3 |
| Y ppm | 5 | 9 | 10 | 14 | 8 | 8 | 5 | 30 | 4 | 3 | 8 | 6 |
| Zr ppm | 5 | 8 | 7 | 8 | 10 | 6 | 5 | 10 | 9 | 9 | 9 | 7 |
| Ag ppm | -0.5 | -0.5 | -0.5 | -0.5 | 1.7 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ba ppm | 10 | 23 | 48 | 113 | 203 | 43 | 12 | 14 | 14 | 17 | 24 | 16 |
| La ppm | 14 | 21 | 24 | 24 | 19 | 20 | 15 | 26 | 6 | 6 | 23 | 22 |
| Ce ppm | 41 | 64 | 70 | 55 | 65 | 65 | 45 | 51 | 28 | 29 | 71 | 69 |
| Pb ppm | 49 | 145 | 307 | 310 | 7268 | 6248 | 2939 | 10000 | 45 | 63 | 815 | 534 |

Table 4d. Analytical data for field duplicates used in the analysis of the -230 mesh fraction of till and stream sediment samples.

YAVA GRID SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| MAP# | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 | 13 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 900 N | 1000 N | 930 N | 930 N | 970 N | 1000 N | 705 N | 750 N | 750 N | 734 N | 750 N | 784 N | 720 N |
| LOCATION | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E | 1400 E |
| Ag ppm | 0.3 | 7.0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 3.0 | 5.0 | 5.0 | 1.5 | 0.3 | 1.0 |
| Al % | 5.58 | i.s. | 4.64 | 5.84 | 3.80 | 4.79 | 5.71 | 5.77 | 5.82 | 5.52 | i.s. | 5.63 | 4.67 |
| Ba ppm | 140 | i.s. | 120 | 130 | 120 | 260 | 310 | 190 | 185 | 120 | i.s. | 140 | 180 |
| Ca % | 2.99 | i.s. | 2.68 | 3.52 | 1.57 | 3.03 | 3.48 | 3.29 | 3.76 | 3.72 | i.s. | 3.13 | 3.27 |
| Cd ppm | 6.0 | 4.0 | 2.0 | 2.0 | 1.5 | 2.5 | 6.5 | 1.5 | 4.8 | 2.0 | 9.5 | 7.5 | 5.0 |
| Co ppm | 33 | 52 | 37 | 21 | 33 | 27 | 17 | 22 | 15 | 13 | 85 | 41 | 27 |
| Cr ppm | 131 | 221 | 336 | 149 | 163 | 107 | 213 | 178 | 263 | 580 | 981 | 146 | 288 |
| Cu ppm | 163 | 41 | 109 | 77 | 26 | 99 | 6 | 65 | 37 | 1 | 1 | 92 | 54 |
| Fe % | 22.16 | i.s. | 22.29 | 22.70 | 11.43 | 18.78 | 19.89 | 21.18 | 18.72 | 18.65 | i.s. | 23.86 | 18.23 |
| K % | 0.47 | 0.48 | 0.32 | 0.40 | 0.40 | 0.33 | 0.43 | 0.36 | 0.39 | 0.31 | 0.32 | 0.44 | 0.33 |
| Mg % | 0.84 | i.s. | 0.53 | 0.70 | 0.49 | 0.59 | 0.81 | 0.78 | 0.79 | 0.76 | i.s. | 0.78 | 0.70 |
| Mn ppm | 3780 | i.s. | 5375 | 4465 | 2885 | 3855 | 4420 | 3895 | 4605 | 5135 | i.s. | 5385 | 5310 |
| Mo ppm | 21 | 22 | 9 | 9 | 6 | 11 | 8 | 12 | 5 | 7 | 1 | 10 | 9 |
| Na % | 0.28 | i.s. | 0.10 | 0.27 | 0.14 | 0.20 | 0.24 | 0.24 | 0.24 | 0.23 | i.s. | 0.25 | 0.15 |
| Ni ppm | 70 | 56 | 50 | 33 | 49 | 48 | 41 | 50 | 30 | 20 | 54 | 54 | 40 |
| P ppm | 2510 | 6190 | 1620 | 2330 | 890 | 2610 | 3990 | 2620 | 3095 | 3670 | 4770 | 2210 | 4240 |
| Pb ppm | 1070 | 2970 | 646 | 532 | 392 | 468 | 294 | 462 | 448 | 696 | 518 | 890 | 1355 |
| Sr ppm | 257 | 224 | 284 | 345 | 233 | 299 | 326 | 320 | 379 | 322 | 199 | 325 | 277 |
| Ti % | 6.03 | i.s. | 8.95 | 7.22 | 6.15 | 7.18 | 11.95 | 8.68 | 11.63 | 11.02 | i.s. | 7.41 | 10.66 |
| V ppm | 259 | 275 | 381 | 277 | 316 | 243 | 326 | 262 | 292 | 284 | 278 | 261 | 256 |
| Zn ppm | 1235 | 388 | 618 | 504 | 454 | 826 | 344 | 836 | 687 | 610 | 370 | 1025 | 894 |
| Zr ppm | 5600 | i.s. | 29400 | 12100 | 23380 | 12000 | 16570 | 20600 | 25050 | 33100 | i.s. | 9800 | 27700 |
| W2 | 400.0 | 234.4 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 |
| W1 | 1.099 | 0.112 | 0.625 | 1.698 | 1.004 | 2.053 | 1.065 | 1.745 | 1.270 | 1.147 | 0.202 | 1.175 | 1.099 |

Table 5a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| MAP# | 16 | 17 | 18 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 480 N | 475 N | 500 N | 534 N | 500 N | 485 N | 500 N | 250 N | 270 N | 250 N | 250 N | 250 N | 250 N |
| LOCATION | 500 W | 250 W | 0 | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E |
| Ag ppm | 0.3 | 0.3 | 7.0 | 1.0 | 0.3 | 0.3 | 22.5 | 10.5 | 7.5 | 10.0 | 1.0 | 7.0 | 1.5 |
| Al % | 6.47 | 5.41 | 4.77 | 4.90 | 5.54 | 6.11 | 3.21 | i.s. | 3.34 | 4.48 | 4.89 | 5.34 | 5.29 |
| Ba ppm | 170 | 120 | 130 | 120 | 720 | 120 | 150 | i.s. | 180 | 190 | 200 | 150 | 140 |
| Ca % | 4.27 | 3.71 | 2.40 | 2.42 | 3.13 | 4.70 | 0.73 | i.s. | 1.13 | 3.11 | 2.89 | 3.76 | 3.64 |
| Cd ppm | 4.5 | 4.0 | 5.0 | 6.0 | 20.5 | 2.0 | 3.5 | 5.5 | 8.5 | 21.0 | 10.5 | 9.0 | 7.0 |
| Co ppm | 28 | 25 | 27 | 42 | 33 | 20 | 40 | 75 | 32 | 38 | 33 | 15 | 23 |
| Cr ppm | 137 | 234 | 279 | 220 | 235 | 252 | 503 | 462 | 495 | 426 | 276 | 293 | 197 |
| Cu ppm | 99 | 22 | 98 | 36 | 40 | 3 | 93 | 1 | 108 | 36 | 48 | 4 | 75 |
| Fe % | 22.16 | 18.64 | 22.11 | 20.02 | 19.45 | 16.64 | 18.35 | i.s. | 17.08 | 17.03 | 19.98 | 18.70 | 21.92 |
| K % | 0.52 | 0.37 | 0.33 | 0.35 | 0.43 | 0.40 | 0.13 | 0.36 | 0.30 | 0.30 | 0.36 | 0.39 | 0.39 |
| Mg % | 0.84 | 0.77 | 0.65 | 0.88 | 0.81 | 0.87 | 0.57 | i.s. | 0.57 | 0.77 | 0.72 | 0.80 | 0.82 |
| Mn ppm | 4190 | 5480 | 4595 | 4900 | 8963 | 4440 | 7115 | i.s. | 6125 | 6265 | 6975 | 6200 | 5585 |
| Mo ppm | 11 | 6 | 11 | 12 | 11 | 5 | 6 | 5 | 10 | 7 | 9 | 6 | 8 |
| Na % | 0.33 | 0.22 | 0.15 | 0.14 | 0.32 | 0.25 | 0.04 | i.s. | 0.08 | 0.14 | 0.21 | 0.19 | 0.21 |
| Ni ppm | 36 | 29 | 60 | 53 | 33 | 22 | 52 | 38 | 27 | 27 | 26 | 16 | 32 |
| P ppm | 2680 | 4550 | 2590 | 3030 | 2505 | 4410 | 1980 | 1770 | 3210 | 8000 | 3530 | 7710 | 6110 |
| Pb ppm | 1030 | 632 | 776 | 476 | 1665 | 800 | 8550 | 390 | 3140 | 850 | 4940 | 3080 | 3590 |
| Sr ppm | 430 | 318 | 261 | 190 | 308 | 443 | 40 | 196 | 143 | 248 | 272 | 309 | 305 |
| Ti % | 5.43 | 10.94 | 9.31 | 11.05 | 9.45 | 10.47 | 10.52 | i.s. | 8.50 | 15.00 | 9.04 | 10.95 | 8.38 |
| V ppm | 282 | 259 | 249 | 235 | 275 | 300 | 331 | 324 | 187 | 252 | 214 | 232 | 233 |
| Zn ppm | 938 | 778 | 908 | 572 | 1295 | 492 | 456 | 290 | 2070 | 1285 | 2280 | 1870 | 2020 |
| Zr ppm | 5250 | 32019 | 24400 | 26600 | 24600 | 23600 | 20000 | i.s. | 41000 | 53000 | 23900 | 37500 | 17180 |
| W2 | 277.1 | 400.0 | 400.0 | 400.0 | 342.4 | 400.0 | 279.4 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 |
| W1 | 1.881 | 1.447 | 1.360 | 0.976 | 1.143 | 0.877 | 3.747 | 0.194 | 0.605 | 0.697 | 1.047 | 1.018 | 1.243 |

Table 5a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| MAP# | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 300 N | 250 N | 0 | 0 | 0 | 0 | 0 | 100 N | 65 N | 0 | 250 S | 250 S | 230 S |
| LOCATION | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 900 E | 1175 E | 500 W | 250 W | 0 |
| Ag ppm | 4.0 | 0.3 | 17.8 | 0.3 | 0.3 | 7.2 | 0.3 | 0.3 | 2.2 | 0.3 | 1.5 | 0.3 | 0.3 |
| Al % | 5.43 | 5.29 | 3.5 | 5.71 | 5.11 | 4.07 | 5.38 | 5.60 | 5.30 | 5.32 | 4.86 | 4.95 | 6.07 |
| Ba ppm | 160 | 210 | 7093 | 170 | 250 | 175 | 170 | 190 | 240 | 200 | 170 | 160 | 150 |
| Ca % | 3.59 | 3.87 | 1.68 | 4.81 | 4.00 | 2.09 | 4.27 | 4.39 | 4.18 | 4.14 | 3.58 | 4.54 | 4.96 |
| Cd ppm | 7.5 | 8.3 | 8.2 | 3.5 | 4.0 | 5.8 | 6.5 | 5.0 | 2.5 | 0.5 | 2.0 | 8.5 | 2.5 |
| Co ppm | 16 | 29 | 24 | 24 | 22 | 20 | 31 | 19 | 17 | 13 | 10 | 27 | 13 |
| Cr ppm | 225 | 250 | 242 | 169 | 132 | 236 | 147 | 267 | 172 | 139 | 119 | 208 | 112 |
| Cu ppm | 36 | 54 | 64 | 23 | 50 | 87 | 63 | 32 | 49 | 22 | 1 | 15 | 13 |
| Fe % | 20.49 | 17.64 | 17.16 | 20.83 | 21.79 | 20.70 | 20.81 | 20.40 | 21.15 | 23.22 | 16.59 | 23.50 | 21.17 |
| K % | 0.40 | 0.39 | 0.40 | 0.46 | 0.42 | 0.47 | 0.42 | 0.50 | 0.37 | 0.52 | 0.33 | 0.39 | 0.44 |
| Mg % | 0.84 | 0.84 | 0.52 | 0.82 | 0.73 | 0.62 | 0.83 | 0.86 | 0.74 | 0.77 | 0.84 | 0.69 | 0.86 |
| Mn ppm | 5330 | 6808 | 5042 | 6530 | 6740 | 7703 | 6695 | 5400 | 5105 | 4705 | 4780 | 5085 | 4395 |
| Mo ppm | 7 | 7 | 7 | 11 | 9 | 11 | 8 | 4 | 9 | 6 | 5 | 4 | 6 |
| Na % | 0.23 | 0.21 | 0.13 | 0.32 | 0.24 | 0.10 | 0.27 | 0.27 | 0.23 | 0.31 | 0.20 | 0.25 | 0.42 |
| Ni ppm | 27 | 32 | 21 | 22 | 25 | 18 | 26 | 18 | 30 | 14 | 27 | 24 | 17 |
| P ppm | 5020 | 4345 | 4413 | 3250 | 2740 | 4050 | 3910 | 4940 | 2795 | 1400 | 5570 | 2350 | 1950 |
| Pb ppm | 3700 | 4118 | 43787 | 3590 | 4320 | 42970 | 11940 | 16200 | 3775 | 836 | 538 | 728 | 448 |
| Sr ppm | 308 | 309 | 143 | 456 | 366 | 189 | 348 | 366 | 364 | 427 | 265 | 416 | 470 |
| Ti % | 8.70 | 10.22 | 4.87 | 8.01 | 7.15 | 4.73 | 7.12 | 7.26 | 6.80 | 8.03 | 14.47 | 8.52 | 7.45 |
| V ppm | 239 | 262 | 159 | 338 | 279 | 156 | 252 | 280 | 307 | 335 | 309 | 407 | 356 |
| Zn ppm | 1805 | 1583 | 1772 | 738 | 892 | 1378 | 1460 | 1115 | 1153 | 430 | 360 | 446 | 470 |
| Zr ppm | 24100 | 20000 | 5200 | 14200 | 17007 | 4320 | 13610 | 14100 | 15390 | 11570 | 16740 | 10000 | 9310 |
| W2 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 389.5 | 400.0 | 400.0 | 400.0 |
| W1 | 1.322 | 1.062 | 3.807 | 1.584 | 1.768 | 1.356 | 1.309 | 1.560 | 1.852 | 1.365 | 1.963 | 1.007 | 1.823 |

Table 5a. Unweighted analytical data for non-magnetic heavy mineral separates (−60+230 mesh fraction).

## YAVA GRID SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| MAP# | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 S | 250 S | 250 S | 250 S | 250 S | 500 S | 508 S | 508 S | 500 S | 500 S | 500 S | 500 S | 750 S |
| LOCATION | 250 E | 485 E | 650 E | 900 E | 1175 E | 500 W | 283 W | 12 W | 250 E | 500 E | 1000 E | 1175 E | 500 W |
| Ag ppm | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Al % | 5.60 | i.s. | 5.02 | 4.92 | 4.92 | 5.65 | 4.92 | 4.19 | i.s. | 5.62 | 5.67 | 5.08 | 4.69 |
| Ba ppm | 360 | i.s. | 150 | 150 | 190 | 280 | 140 | 170 | i.s. | 220 | 190 | 170 | 3530 |
| Ca % | 3.44 | i.s. | 3.99 | 4.04 | 3.98 | 4.43 | 4.01 | 3.54 | i.s. | 3.91 | 4.12 | 3.99 | 4.25 |
| Cd ppm | 0.3 | 0.3 | 0.5 | 1.0 | 0.5 | 2.0 | 0.3 | 1.3 | 0.3 | 0.3 | 0.5 | 2.5 | 1.0 |
| Co ppm | 26 | 73 | 25 | 14 | 12 | 22 | 15 | 8 | 30 | 21 | 18 | 10 | 15 |
| Cr ppm | 90 | 127 | 130 | 135 | 122 | 125 | 95 | 123 | 122 | 89 | 143 | 176 | 106 |
| Cu ppm | 22 | 168 | 38 | 52 | 1 | 7 | 14 | 18 | 29 | 16 | 2 | 1 | 1 |
| Fe % | 24.04 | i.s. | 16.04 | 24.46 | 24.18 | 23.54 | 23.32 | 17.23 | i.s. | 24.25 | 23.11 | 23.67 | 19.25 |
| K % | 0.55 | 0.73 | 0.48 | 0.48 | 0.64 | 0.49 | 0.38 | 0.48 | 0.48 | 0.67 | 0.59 | 0.56 | 0.53 |
| Mg % | 0.72 | i.s. | 0.67 | 0.71 | 0.73 | 0.73 | 0.46 | 0.61 | i.s. | 0.88 | 0.78 | 0.77 | 0.68 |
| Mn ppm | 3700 | i.s. | 3895 | 5330 | 4430 | 6245 | 3430 | 4578 | i.s. | 4140 | 4615 | 3630 | 3320 |
| Mo ppm | 7 | 9 | 8 | 7 | 6 | 7 | 6 | 6 | 10 | 6 | 2 | 6 | 4 |
| Na % | 0.20 | i.s. | 0.26 | 0.26 | 0.32 | 0.27 | 0.23 | 0.23 | i.s. | 0.42 | 0.34 | 0.33 | 0.24 |
| Ni ppm | 24 | 23 | 27 | 19 | 20 | 18 | 22 | 12 | 29 | 27 | 20 | 19 | 19 |
| P ppm | 20 | 1420 | 630 | 1190 | 1590 | 510 | 890 | 645 | 290 | 270 | 1780 | 1270 | 1220 |
| Pb ppm | 392 | 968 | 270 | 624 | 174 | 520 | 172 | 392 | 274 | 464 | 226 | 198 | 166 |
| Sr ppm | 330 | 323 | 381 | 392 | 407 | 462 | 450 | 487 | 372 | 488 | 402 | 399 | 456 |
| Ti % | 6.00 | i.s. | 4.52 | 7.38 | 7.78 | 7.75 | 7.48 | 6.34 | i.s. | 7.14 | 7.53 | 7.70 | 7.82 |
| V ppm | 355 | 357 | 343 | 375 | 342 | 347 | 375 | 370 | 371 | 363 | 331 | 378 | 330 |
| Zn ppm | 308 | 578 | 186 | 232 | 170 | 230 | 166 | 341 | 228 | 234 | 196 | 216 | 172 |
| Zr ppm | 10900 | i.s. | 10730 | 9150 | 6300 | 7600 | 11100 | 7400 | i.s. | 4100 | 10912 | 11100 | 8000 |
| W2 | 166.2 | 232.8 | 350.8 | 440.3 | 400.0 | 400.0 | 310.0 | 142.5 | 258.3 | 318.7 | 435.2 | 423.6 | 400.0 |
| W1 | 1.053 | 0.239 | 1.310 | 1.324 | 1.457 | 1.523 | 1.648 | 0.503 | 0.829 | 0.725 | 2.397 | 1.184 | 1.739 |

Table 5a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

## YAVA GRID SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| MAP# | 56 | 57 | 58 | 59 | 61 | 62 |
|---|---|---|---|---|---|---|
| GRID- | 750 S | 750 S | 750 S | 750 S | 750 S | 750 |
| LOCATION | 295 W | 0 | 250 E | 470 E | 1000 E | 1175 |
| | | | | | | |
| Ag ppm | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Al % | 5.91 | 4.94 | 5.20 | 4.55 | 4.78 | 4.04 |
| Ba ppm | 2160 | 240 | 200 | 100 | 230 | 140 |
| Ca % | 5.62 | 4.10 | 3.79 | 4.85 | 0.79 | 3.45 |
| Cd ppm | 4.0 | 0.5 | 0.3 | 1.5 | 0.3 | 0.3 |
| Co ppm | 1 | 7 | 6 | 6 | 10 | 15 |
| Cr ppm | 101 | 126 | 76 | 126 | 150 | 106 |
| Cu ppm | 1 | 12 | 1 | 1 | 1 | 1 |
| Fe % | 20.64 | 13.88 | 21.25 | 21.79 | 4.13 | 24.25 |
| K % | 0.68 | 0.59 | 0.71 | 0.49 | 1.17 | 0.53 |
| Mg % | 0.71 | 0.72 | 1.43 | 1.63 | 0.43 | 1.05 |
| Mn ppm | 3075 | 3105 | 4155 | 6495 | 673 | 3620 |
| Mo ppm | 1 | 3 | 1 | 1 | 1 | 4 |
| Na % | 0.51 | 0.27 | 0.56 | 0.32 | 1.57 | 0.24 |
| Ni ppm | 10 | 17 | 17 | 18 | 11 | 22 |
| P ppm | 3600 | 730 | 580 | 660 | 300 | 950 |
| Pb ppm | 152 | 288 | 370 | 104 | 111 | 108 |
| Sr ppm | 564 | 452 | 336 | 361 | 134 | 285 |
| Ti % | 8.55 | 5.25 | 6.86 | 11.91 | 1.05 | 8.32 |
| V ppm | 366 | 348 | 283 | 375 | 72 | 372 |
| Zn ppm | 170 | 182 | 182 | 146 | 54 | 124 |
| Zr ppm | 2700 | 6400 | 2800 | 4070 | 375 | 4460 |
| W2 | 400.0 | 346.5 | 420.6 | 367.6 | 311.9 | 406.2 |
| W1 | 1.023 | 0.851 | 2.066 | 1.361 | 19.861 | 1.461 |

Table 5a. Unweighted analytical data for non-magnetic heavy mineral separates (−60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 900 N | 1000 N | 930 N | 930 N | 970 N | 1000 N | 705 N | 750 N | 750 N | 734 N | 750 N |
| LOCATION | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 250 W | 0 | 250 E | 500 E | 750 E |
| Wt.V. | | | | | | | | | | | |
| Ag | 0.0008 | 0.0033 | 0.0005 | 0.0013 | 0.0008 | 0.0015 | 0.0008 | 0.0131 | 0.0159 | 0.0143 | 0.0008 |
| Al | 0.0153 | i.s. | 0.0073 | 0.0248 | 0.0095 | 0.0246 | 0.0152 | 0.0252 | 0.0185 | 0.0158 | i.s. |
| Ba | 0.3847 | i.s. | 0.1875 | 0.5519 | 0.3012 | 1.3345 | 0.8254 | 0.8289 | 0.5874 | 0.3441 | i.s. |
| Ca | 0.0082 | i.s. | 0.0042 | 0.0149 | 0.0039 | 0.0156 | 0.0093 | 0.0144 | 0.0119 | 0.0107 | i.s. |
| Cd | 0.0165 | 0.0019 | 0.0031 | 0.0085 | 0.0038 | 0.0128 | 0.0173 | 0.0065 | 0.0151 | 0.0057 | 0.0048 |
| Co | 0.0907 | 0.0248 | 0.0578 | 0.0891 | 0.0828 | 0.1386 | 0.0453 | 0.0960 | 0.0476 | 0.0373 | 0.0429 |
| Cr | 0.3599 | 0.1056 | 0.5250 | 0.6325 | 0.4091 | 0.5492 | 0.5671 | 0.7765 | 0.8350 | 1.6632 | 0.4954 |
| Cu | 0.4478 | 0.0196 | 0.1703 | 0.3269 | 0.0653 | 0.5081 | 0.0160 | 0.2836 | 0.1175 | 0.0029 | 0.0005 |
| Fe | 0.0609 | i.s. | 0.0348 | 0.0964 | 0.0287 | 0.0964 | 0.0530 | 0.0924 | 0.0594 | 0.0535 | i.s. |
| K | 0.0013 | 0.0002 | 0.0005 | 0.0017 | 0.0010 | 0.0017 | 0.0011 | 0.0016 | 0.0012 | 0.0009 | 0.0002 |
| Mg | 0.0023 | i.s. | 0.0008 | 0.0030 | 0.0012 | 0.0030 | 0.0022 | 0.0034 | 0.0025 | 0.0022 | i.s. |
| Mn | 10.3856 | i.s. | 8.3984 | 18.9539 | 7.2414 | 19.7858 | 11.7683 | 16.9919 | 14.6209 | 14.7246 | i.s. |
| Mo | 0.0577 | 0.0105 | 0.0141 | 0.0382 | 0.0151 | 0.0565 | 0.0213 | 0.0524 | 0.0159 | 0.0201 | 0.0005 |
| Na | 0.0008 | i.s. | 0.0002 | 0.0011 | 0.0004 | 0.0010 | 0.0006 | 0.0010 | 0.0007 | 0.0007 | i.s. |
| Ni | 0.1923 | 0.0268 | 0.0781 | 0.1401 | 0.1230 | 0.2464 | 0.1092 | 0.2181 | 0.0953 | 0.0574 | 0.0273 |
| P | 6.8962 | 2.9577 | 2.5313 | 9.8909 | 2.2339 | 13.3958 | 10.6234 | 11.4298 | 9.8266 | 10.5237 | 2.4089 |
| Pb | 2.9398 | 1.4191 | 1.0094 | 2.2583 | 0.9839 | 2.4020 | 0.7828 | 2.0155 | 1.4224 | 1.9958 | 0.2616 |
| Sr | 0.7061 | 0.1070 | 0.4438 | 1.4645 | 0.5848 | 1.5346 | 0.8680 | 1.3960 | 1.2017 | 0.9233 | 0.1005 |
| Ti | 0.0166 | i.s. | 0.0140 | 0.0306 | 0.0154 | 0.0369 | 0.0318 | 0.0379 | 0.0369 | 0.0316 | i.s. |
| V | 0.7116 | 0.1314 | 0.5953 | 1.1759 | 0.7932 | 1.2472 | 0.8680 | 1.1430 | 0.9255 | 0.8144 | 0.1404 |
| Zn | 3.3932 | 0.1854 | 0.9656 | 2.1395 | 1.1395 | 4.2394 | 0.9159 | 3.6471 | 2.1812 | 1.7492 | 0.1869 |
| Zr | 15.3860 | i.s. | 45.9375 | 51.3645 | 58.6838 | 61.5900 | 44.1176 | 89.8675 | 79.5338 | 94.9143 | i.s. |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 13 | 15 | 16 | 17 | 18 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 784 N | 720 N | 480 N | 475 N | 500 N | 534 N | 500 N | 485 N | 500 N | 250 N | 270 N |
| LOCATION | 1000 E | 1400 E | 500 W | 250 W | 0 | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W |
| Wt.V. | | | | | | | | | | | |
| Ag | 0.0009 | 0.0027 | 0.0020 | 0.0011 | 0.0238 | 0.0024 | 0.0010 | 0.0007 | 0.3017 | 0.0051 | 0.0113 |
| Al | 0.0165 | 0.0128 | 0.0439 | 0.0196 | 0.0162 | 0.0120 | 0.0185 | 0.0134 | 0.0430 | i.s. | 0.0051 |
| Ba | 0.4113 | 0.4946 | 1.1540 | 0.4341 | 0.4420 | 0.2928 | 2.4035 | 0.2631 | 2.0116 | i.s. | 0.2723 |
| Ca | 0.0092 | 0.0090 | 0.0290 | 0.0134 | 0.0082 | 0.0059 | 0.0104 | 0.0103 | 0.0098 | i.s. | 0.0017 |
| Cd | 0.0220 | 0.0137 | 0.0305 | 0.0145 | 0.0170 | 0.0146 | 0.0684 | 0.0044 | 0.0469 | 0.0027 | 0.0129 |
| Co | 0.1204 | 0.0742 | 0.1901 | 0.0904 | 0.0918 | 0.1025 | 0.1102 | 0.0439 | 0.5364 | 0.0364 | 0.0484 |
| Cr | 0.4289 | 0.7913 | 0.9300 | 0.8465 | 0.9486 | 0.5368 | 0.7845 | 0.5525 | 6.7457 | 0.2241 | 0.7487 |
| Cu | 0.2703 | 0.1484 | 0.6720 | 0.0796 | 0.3332 | 0.0878 | 0.1335 | 0.0066 | 1.2472 | 0.0005 | 0.1634 |
| Fe | 0.0701 | 0.0501 | 0.1504 | 0.0674 | 0.0752 | 0.0488 | 0.0649 | 0.0365 | 0.2461 | i.s. | 0.0258 |
| K | 0.0013 | 0.0009 | 0.0035 | 0.0013 | 0.0011 | 0.0009 | 0.0014 | 0.0009 | 0.0017 | 0.0002 | 0.0005 |
| Mg | 0.0023 | 0.0019 | 0.0057 | 0.0028 | 0.0022 | 0.0021 | 0.0027 | 0.0019 | 0.0076 | i.s. | 0.0009 |
| Mn | 15.8184 | 14.5892 | 28.4424 | 19.8239 | 15.6230 | 11.9560 | 29.9186 | 9.7347 | 95.4184 | i.s. | 9.2641 |
| Mo | 0.0294 | 0.0247 | 0.0747 | 0.0217 | 0.0374 | 0.0293 | 0.0367 | 0.0110 | 0.0805 | 0.0024 | 0.0151 |
| Na | 0.0007 | 0.0004 | 0.0022 | 0.0008 | 0.0005 | 0.0003 | 0.0011 | 0.0005 | 0.0005 | i.s. | 0.0001 |
| Ni | 0.1586 | 0.1099 | 0.2444 | 0.1049 | 0.2040 | 0.1293 | 0.1102 | 0.0482 | 0.6974 | 0.0184 | 0.0408 |
| P | 6.4919 | 11.6494 | 18.1923 | 16.4596 | 8.8060 | 7.3932 | 8.3622 | 9.6689 | 26.5535 | 0.8585 | 4.8551 |
| Pb | 2.6144 | 3.7229 | 6.9918 | 2.2863 | 2.6384 | 1.1614 | 5.5581 | 1.7540 | 114.6630 | 0.1892 | 4.7493 |
| Sr | 0.9547 | 0.7611 | 2.9189 | 1.1504 | 0.8874 | 0.4636 | 1.0265 | 0.9713 | 0.5364 | 0.0951 | 0.2163 |
| Ti | 0.0218 | 0.0293 | 0.0369 | 0.0396 | 0.0317 | 0.0270 | 0.0315 | 0.0230 | 0.1411 | i.s. | 0.0129 |
| V | 0.7667 | 0.7034 | 1.9143 | 0.9369 | 0.8466 | 0.5734 | 0.9163 | 0.6578 | 4.4390 | 0.1571 | 0.2828 |
| Zn | 3.0109 | 2.4563 | 6.3673 | 2.8144 | 3.0872 | 1.3957 | 4.3230 | 1.0787 | 6.1154 | 0.1407 | 3.1309 |
| Zr | 28.7875 | 76.1058 | 35.6379 | 115.8287 | 82.9600 | 64.9040 | 82.1181 | 51.7430 | 268.2176 | i.s. | 62.0125 |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 N | 250 N | 250 N | 250 N | 300 N | 250 N | 0 | 0 | 0 | 0 | 0 |
| LOCATION | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E |
| Wt. V. | | | | | | | | | | | |
| Ag | 0.0174 | 0.0026 | 0.0178 | 0.0047 | 0.0132 | 0.0008 | 0.1697 | 0.0012 | 0.0013 | 0.0242 | 0.0010 |
| Al | 0.0078 | 0.0128 | 0.0136 | 0.0164 | 0.0179 | 0.0140 | 0.0330 | 0.0226 | 0.0226 | 0.0138 | 0.0176 |
| Ba | 0.3311 | 0.5235 | 0.3818 | 0.4351 | 0.5288 | 0.5576 | 67.5108 | 0.6732 | 1.1050 | 0.5933 | 0.5563 |
| Ca | 0.0054 | 0.0076 | 0.0096 | 0.0113 | 0.0119 | 0.0103 | 0.0160 | 0.0190 | 0.0177 | 0.0071 | 0.0140 |
| Cd | 0.0366 | 0.0275 | 0.0229 | 0.0218 | 0.0248 | 0.0219 | 0.0777 | 0.0139 | 0.0177 | 0.0195 | 0.0213 |
| Co | 0.0662 | 0.0864 | 0.0382 | 0.0715 | 0.0529 | 0.0757 | 0.2252 | 0.0950 | 0.0972 | 0.0678 | 0.1014 |
| Cr | 0.7423 | 0.7224 | 0.7457 | 0.6122 | 0.7436 | 0.6624 | 2.3001 | 0.6692 | 0.5834 | 0.8000 | 0.4811 |
| Cu | 0.0627 | 0.1256 | 0.0102 | 0.2331 | 0.1190 | 0.1420 | 0.6059 | 0.0911 | 0.2210 | 0.2949 | 0.2062 |
| Fe | 0.0297 | 0.0523 | 0.0476 | 0.0681 | 0.0677 | 0.0468 | 0.1634 | 0.0825 | 0.0963 | 0.0702 | 0.0681 |
| K | 0.0005 | 0.0009 | 0.0010 | 0.0012 | 0.0013 | 0.0010 | 0.0038 | 0.0018 | 0.0019 | 0.0016 | 0.0014 |
| Mg | 0.0013 | 0.0019 | 0.0020 | 0.0025 | 0.0028 | 0.0022 | 0.0049 | 0.0032 | 0.0032 | 0.0021 | 0.0027 |
| Mn | 10.9168 | 18.2571 | 15.7790 | 17.3554 | 17.6157 | 18.0739 | 47.9841 | 25.8588 | 29.7908 | 26.1115 | 21.9094 |
| Mo | 0.0122 | 0.0236 | 0.0153 | 0.0249 | 0.0231 | 0.0173 | 0.0666 | 0.0436 | 0.0398 | 0.0373 | 0.0262 |
| Na | 0.0002 | 0.0005 | 0.0005 | 0.0007 | 0.0008 | 0.0006 | 0.0012 | 0.0013 | 0.0011 | 0.0003 | 0.0009 |
| Ni | 0.0470 | 0.0681 | 0.0407 | 0.0994 | 0.0892 | 0.0850 | 0.2030 | 0.0871 | 0.1105 | 0.0610 | 0.0851 |
| P | 13.9400 | 9.2398 | 19.6220 | 18.9868 | 16.5911 | 11.5360 | 42.0039 | 12.8700 | 12.1108 | 13.7295 | 12.7955 |
| Pb | 1.4811 | 12.9305 | 7.8386 | 11.1559 | 12.2285 | 10.9320 | 416.7396 | 14.2164 | 19.0944 | 145.6683 | 39.0737 |
| Sr | 0.4321 | 0.7120 | 0.7864 | 0.9478 | 1.0179 | 0.8204 | 1.3610 | 1.8058 | 1.6177 | 0.6390 | 1.1388 |
| Ti | 0.0261 | 0.0237 | 0.0279 | 0.0260 | 0.0288 | 0.0271 | 0.0463 | 0.0317 | 0.0316 | 0.0160 | 0.0233 |
| V | 0.4391 | 0.5601 | 0.5904 | 0.7240 | 0.7899 | 0.6956 | 1.5133 | 1.3385 | 1.2332 | 0.5288 | 0.8247 |
| Zn | 2.2391 | 5.9679 | 4.7592 | 6.2772 | 5.9655 | 4.2015 | 16.8618 | 2.9225 | 3.9426 | 4.6697 | 4.7779 |
| Zr | 92.3525 | 62.5583 | 95.4375 | 53.3869 | 79.6505 | 53.1000 | 49.4910 | 56.2320 | 75.1709 | 14.6448 | 44.5387 |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 100 N | 65 N | 0 | 250 S | 250 S | 230 S | 250 S | 250 S | 250 S | 250 S | 250 S |
| LOCATION | 750 E | 900 E | 1175 E | 500 W | 250 W | 0 | 250 E | 485 E | 650 E | 900 E | 1175 E |
| Wt.V. | | | | | | | | | | | |
| Ag | 0.0012 | 0.0100 | 0.0011 | 0.0074 | 0.0008 | 0.0014 | 0.0019 | 0.0003 | 0.0011 | 0.0009 | 0.0011 |
| Al | 0.0218 | 0.0245 | 0.0186 | 0.0239 | 0.0125 | 0.0277 | 0.0355 | i.s. | 0.0187 | 0.0148 | 0.0179 |
| Ba | 0.7410 | 1.1112 | 0.7009 | 0.8343 | 0.4028 | 0.6836 | 2.2809 | i.s. | 0.5601 | 0.4511 | 0.6921 |
| Ca | 0.0171 | 0.0194 | 0.0145 | 0.0176 | 0.0114 | 0.0226 | 0.0218 | i.s. | 0.0149 | 0.0121 | 0.0145 |
| Cd | 0.0195 | 0.0116 | 0.0018 | 0.0098 | 0.0214 | 0.0114 | 0.0019 | 0.0003 | 0.0019 | 0.0030 | 0.0018 |
| Co | 0.0741 | 0.0787 | 0.0456 | 0.0491 | 0.0680 | 0.0592 | 0.1647 | 0.0749 | 0.0934 | 0.0421 | 0.0437 |
| Cr | 1.0413 | 0.7940 | 0.4871 | 0.5840 | 0.5236 | 0.5104 | 0.5702 | 0.1304 | 0.4855 | 0.4060 | 0.4444 |
| Cu | 0.1248 | 0.2269 | 0.0771 | 0.0049 | 0.0378 | 0.0592 | 0.1394 | 0.1725 | 0.1419 | 0.1564 | 0.0036 |
| Fe | 0.0796 | 0.0979 | 0.0814 | 0.0814 | 0.0592 | 0.0965 | 0.1523 | i.s. | 0.0599 | 0.0736 | 0.0881 |
| K | 0.0020 | 0.0017 | 0.0018 | 0.0016 | 0.0010 | 0.0020 | 0.0035 | 0.0007 | 0.0018 | 0.0014 | 0.0023 |
| Mg | 0.0034 | 0.0034 | 0.0027 | 0.0041 | 0.0017 | 0.0039 | 0.0046 | i.s. | 0.0025 | 0.0021 | 0.0027 |
| Mn | 21.0600 | 23.6362 | 16.4886 | 23.4579 | 12.8015 | 20.0302 | 23.4422 | i.s. | 14.5452 | 16.0275 | 16.1363 |
| Mo | 0.0156 | 0.0417 | 0.0210 | 0.0245 | 0.0101 | 0.0273 | 0.0444 | 0.0092 | 0.0299 | 0.0210 | 0.0219 |
| Na | 0.0011 | 0.0011 | 0.0011 | 0.0010 | 0.0006 | 0.0019 | 0.0013 | i.s. | 0.0010 | 0.0008 | 0.0012 |
| Ni | 0.0702 | 0.1366 | 0.0491 | 0.1325 | 0.0604 | 0.0775 | 0.1521 | 0.0236 | 0.1008 | 0.0571 | 0.0729 |
| P | 19.2660 | 12.9409 | 4.9063 | 27.3348 | 5.9161 | 8.8871 | 0.1267 | 1.4578 | 2.3526 | 3.5784 | 5.7916 |
| Pb | 63.1800 | 17.4783 | 2.9298 | 2.6402 | 1.8327 | 2.0418 | 2.4836 | 0.9938 | 1.0083 | 1.8764 | 0.6338 |
| Sr | 1.4274 | 1.6853 | 1.4964 | 1.3005 | 1.0473 | 2.1420 | 2.0908 | 0.3316 | 1.4228 | 1.1788 | 1.4825 |
| Ti | 0.0283 | 0.0315 | 0.0281 | 0.0710 | 0.0214 | 0.0340 | 0.0380 | i.s. | 0.0169 | 0.0222 | 0.0283 |
| V | 1.0920 | 1.4214 | 1.1740 | 1.5164 | 1.0246 | 1.6225 | 2.2492 | 0.3665 | 1.2809 | 1.1276 | 1.2457 |
| Zn | 4.3485 | 5.3361 | 1.5069 | 1.7667 | 1.1228 | 2.1420 | 1.9514 | 0.5934 | 0.6946 | 0.6976 | 0.6192 |
| Zr | 54.9900 | 71.2557 | 40.5470 | 82.1516 | 25.1750 | 42.4303 | 69.0596 | i.s. | 40.0693 | 27.5144 | 22.9478 |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (−60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 500 S | 508 S | 508 S | 500 S | 500 S | 500 S | 500 S | 750 S | 750 S | 750 S | 750 S |
| LOCATION | 500 W | 283 W | 12 W | 250 E | 500 E | 1000 E | 1175 E | 500 W | 295 W | 0 | 250 E |
| Wt.V. | | | | | | | | | | | |
| Ag | 0.0011 | 0.0016 | 0.0011 | 0.0010 | 0.0007 | 0.0017 | 0.0008 | 0.0013 | 0.0008 | 0.0007 | 0.0015 |
| Al | 0.0215 | 0.0262 | 0.0148 | i.s. | 0.0128 | 0.0312 | 0.0142 | 0.0204 | 0.0151 | 0.0121 | 0.0255 |
| Ba | 1.0661 | 0.7443 | 0.6001 | i.s. | 0.5005 | 1.0465 | 0.4752 | 15.3467 | 5.5242 | 0.5894 | 0.9824 |
| Ca | 0.0169 | 0.0213 | 0.0125 | i.s. | 0.0089 | 0.0227 | 0.0112 | 0.0185 | 0.0144 | 0.0101 | 0.0186 |
| Cd | 0.0076 | 0.0016 | 0.0044 | 0.0010 | 0.0007 | 0.0028 | 0.0070 | 0.0043 | 0.0102 | 0.0012 | 0.0015 |
| Co | 0.0838 | 0.0797 | 0.0282 | 0.0963 | 0.0478 | 0.0991 | 0.0280 | 0.0652 | 0.0026 | 0.0172 | 0.0295 |
| Cr | 0.4759 | 0.5050 | 0.4324 | 0.3916 | 0.2025 | 0.7876 | 0.4919 | 0.4608 | 0.2583 | 0.3095 | 0.3733 |
| Cu | 0.0267 | 0.0744 | 0.0618 | 0.0931 | 0.0364 | 0.0110 | 0.0028 | 0.0043 | 0.0026 | 0.0295 | 0.0049 |
| Fe | 0.0896 | 0.1240 | 0.0608 | i.s. | 0.0552 | 0.1273 | 0.0662 | 0.0837 | 0.0528 | 0.0341 | 0.1044 |
| K | 0.0019 | 0.0020 | 0.0017 | 0.0015 | 0.0015 | 0.0032 | 0.0016 | 0.0023 | 0.0017 | 0.0014 | 0.0035 |
| Mg | 0.0028 | 0.0024 | 0.0021 | i.s. | 0.0020 | 0.0043 | 0.0022 | 0.0030 | 0.0018 | 0.0018 | 0.0070 |
| Mn | 23.7778 | 18.2343 | 16.1578 | i.s. | 9.4179 | 25.4186 | 10.1462 | 14.4337 | 7.8643 | 7.6258 | 20.4095 |
| Mo | 0.0267 | 0.0319 | 0.0194 | 0.0321 | 0.0136 | 0.0110 | 0.0168 | 0.0174 | 0.0026 | 0.0074 | 0.0049 |
| Na | 0.0010 | 0.0012 | 0.0008 | i.s. | 0.0010 | 0.0019 | 0.0009 | 0.0010 | 0.0013 | 0.0007 | 0.0028 |
| Ni | 0.0685 | 0.1170 | 0.0406 | 0.0931 | 0.0614 | 0.1102 | 0.0531 | 0.0826 | 0.0256 | 0.0418 | 0.0835 |
| P | 1.9418 | 4.7314 | 2.2767 | 0.9307 | 0.6142 | 9.8039 | 3.5498 | 5.3040 | 9.2070 | 1.7929 | 2.8490 |
| Pb | 1.9799 | 0.9144 | 1.3837 | 0.8794 | 1.0555 | 1.2448 | 0.5534 | 0.7217 | 0.3887 | 0.7073 | 1.8175 |
| Sr | 1.7591 | 2.3923 | 1.7173 | 1.1939 | 1.1101 | 2.2141 | 1.1152 | 1.9825 | 1.4424 | 1.1101 | 1.6504 |
| Ti | 0.0295 | 0.0398 | 0.0224 | i.s. | 0.0162 | 0.0415 | 0.0215 | 0.0340 | 0.0219 | 0.0129 | 0.0337 |
| V | 1.3212 | 1.9935 | 1.3060 | 1.1907 | 0.8258 | 1.8231 | 1.0565 | 1.4347 | 0.9360 | 0.8547 | 1.3901 |
| Zn | 0.8757 | 0.8825 | 1.2037 | 0.7318 | 0.5323 | 1.0795 | 0.6037 | 0.7478 | 0.4348 | 0.4470 | 0.8940 |
| Zr | 28.9370 | 59.0090 | 26.1207 | i.s. | 9.3270 | 60.1013 | 31.0255 | 34.7800 | 6.9053 | 15.7183 | 13.7537 |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (−60+230 mesh fraction).

YAVA GRID SURVEY 1990 WEIGHTED HEAVY MINERALS

| MAP# | 59 | 61 | 62 |
|---|---|---|---|
| GRID- | 750 S | 750 S | 750 S |
| LOCATION | 470 E | 1000 E | 1175 E |
| Wt.V. | | | |
| Ag | 0.0011 | 0.0191 | 0.0011 |
| Al | 0.0168 | 0.3041 | 0.0145 |
| Ba | 0.3702 | 14.6458 | 0.5035 |
| Ca | 0.0180 | 0.0500 | 0.0124 |
| Cd | 0.0056 | 0.0191 | 0.0011 |
| Co | 0.0222 | 0.6368 | 0.0540 |
| Cr | 0.4665 | 9.5516 | 0.3813 |
| Cu | 0.0037 | 0.0637 | 0.0036 |
| Fe | 0.0807 | 0.2627 | 0.0872 |
| K | 0.0018 | 0.0745 | 0.0019 |
| Mg | 0.0060 | 0.0274 | 0.0038 |
| Mn | 24.0470 | 42.8231 | 13.0202 |
| Mo | 0.0037 | 0.0637 | 0.0144 |
| Na | 0.0012 | 0.1000 | 0.0009 |
| Ni | 0.0666 | 0.6686 | 0.0791 |
| P | 2.4436 | 19.1032 | 3.4169 |
| Pb | 0.3850 | 7.0682 | 0.3884 |
| Sr | 1.3366 | 8.5009 | 1.0251 |
| Ti | 0.0441 | 0.0669 | 0.0299 |
| V | 1.3884 | 4.5529 | 1.3380 |
| Zn | 0.5405 | 3.4386 | 0.4460 |
| Zr | 15.0687 | 23.8790 | 16.0415 |

Table 5b. Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA GRID SURVEY 1990 STANDARDS

| | STD91BS | STD91BS | STD91BS | STD91BS | STD91BS | STD91BS | STD91BS | STD91H | STD91H | STD91H | STD91H | STD91H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag ppm | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 4.0 | 2.5 | 2.5 | 2.0 | 3.0 |
| Al % | 7.95 | 7.99 | 7.90 | 7.81 | 8.08 | 8.02 | 7.84 | 5.94 | 5.72 | 6.06 | 5.98 | 5.97 |
| Ba ppm | 1990 | 1900 | 2040 | 2060 | 2170 | 2170 | 2190 | 1140 | 1210 | 1120 | 1100 | 1150 |
| Ca % | 1.93 | 1.99 | 1.87 | 1.84 | 1.76 | 1.86 | 1.83 | 0.77 | 0.88 | 0.85 | 0.82 | 0.82 |
| Cd ppm | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 49.0 | 47.0 | 51.0 | 53.5 | 50.5 |
| Co ppm | 10 | 10 | 12 | 5 | 1 | 4 | 3 | 17 | 16 | 16 | 17 | 20 |
| Cr ppm | 18 | 1 | 365 | 407 | 19 | 685 | 145 | 48 | 33 | 48 | 49 | 47 |
| Cu ppm | 1 | 1 | 1 | 2 | 2 | 4 | 1 | 1875 | 1780 | 1890 | 1950 | 1825 |
| Fe % | 3.51 | 3.95 | 3.58 | 3.64 | 2.58 | 3.66 | 3.36 | 3.72 | 3.25 | 3.86 | 3.76 | 3.74 |
| K % | 3.23 | 3.43 | 2.66 | 3.66 | 4.12 | 3.85 | 3.36 | 1.37 | 1.29 | 1.44 | 1.43 | 1.39 |
| Mg % | 0.45 | 0.45 | 0.41 | 0.41 | 0.36 | 0.40 | 0.40 | 0.68 | 0.70 | 0.76 | 0.70 | 0.73 |
| Mn ppm | 860 | 895 | 775 | 765 | 625 | 720 | 850 | 1470 | 1570 | 1515 | 1480 | 1505 |
| Mo ppm | 3 | 2 | 1 | 1 | 3 | 1 | 1 | 10 | 8 | 10 | 13 | 12 |
| Na % | 2.65 | 2.53 | 2.53 | 2.51 | 2.59 | 2.56 | 2.56 | 0.81 | 0.82 | 0.83 | 0.81 | 0.82 |
| Ni ppm | 3 | 2 | 10 | 1 | 1 | 15 | 3 | 22 | 21 | 21 | 17 | 17 |
| P ppm | 800 | 730 | 1070 | 1080 | 980 | 1200 | 1140 | 490 | 610 | 560 | 710 | 680 |
| Pb ppm | 38 | 56 | 26 | 26 | 50 | 28 | 40 | 1695 | 1645 | 1655 | 1750 | 1635 |
| Sr ppm | 406 | 415 | 404 | 410 | 419 | 423 | 406 | 98 | 88 | 93 | 93 | 90 |
| Ti % | 0.69 | 0.78 | 0.59 | 0.59 | 0.43 | 0.53 | 0.58 | 0.65 | 0.84 | 0.69 | 0.66 | 0.70 |
| V ppm | 19 | 16 | 15 | 17 | 13 | 16 | 18 | 68 | 65 | 67 | 68 | 67 |
| Zn ppm | 114 | 110 | 110 | 106 | 96 | 106 | 108 | 15780 | 15490 | 15980 | 16650 | 13510 |
| Zr ppm | 964 | 700 | 700 | 670 | 370 | 570 | 640 | 891 | 800 | 900 | 790 | 880 |

Table 5c. Unweighted analytical data for standards used in heavy mineral analysis.

YAVA GRID SURVEY 1990 STANDARDS

| | STD91H | STD91H | STD91L | STD91L | STD91L | STD91L | STD91L | STD91L | STD91L |
|---|---|---|---|---|---|---|---|---|---|
| Ag ppm | 2.5 | 2.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Al % | 6.01 | 5.88 | 6.17 | 5.92 | 6.29 | 3.03 | 6.28 | 6.22 | 6.22 |
| Ba ppm | 1240 | 1230 | 1150 | 1100 | 1170 | 580 | 1240 | 1260 | 1240 |
| Ca % | 0.81 | 0.76 | 0.55 | 0.56 | 0.55 | 0.06 | 0.55 | 0.54 | 0.55 |
| Cd ppm | 49.0 | 49.5 | 0.3 | 0.5 | 0.5 | 0.3 | 0.5 | 0.3 | 0.3 |
| Co ppm | 11 | 12 | 23 | 15 | 14 | 17 | 10 | 11 | 12 |
| Cr ppm | 45 | 55 | 43 | 55 | 51 | 43 | 56 | 43 | 53 |
| Cu ppm | 1895 | 1895 | 13 | 13 | 15 | 14 | 17 | 13 | 13 |
| Fe % | 3.84 | 3.69 | 3.49 | 3.07 | 3.66 | 1.55 | 3.62 | 3.61 | 3.60 |
| K % | 1.27 | 1.30 | 1.38 | 1.42 | 1.43 | 1.45 | 1.46 | 1.33 | 1.34 |
| Mg % | 0.72 | 0.68 | 0.78 | 0.77 | 0.78 | 0.31 | 0.80 | 0.77 | 0.78 |
| Mn ppm | 1500 | 1475 | 1565 | 1720 | 1620 | 785 | 1615 | 1630 | 1575 |
| Mo ppm | 10 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Na % | 0.81 | 0.82 | 0.96 | 0.90 | 0.91 | 0.38 | 0.92 | 0.89 | 0.90 |
| Ni ppm | 21 | 21 | 23 | 21 | 21 | 18 | 23 | 22 | 22 |
| P ppm | 830 | 690 | 360 | 620 | 650 | 760 | 820 | 840 | 790 |
| Pb ppm | 1665 | 1650 | 42 | 34 | 58 | 48 | 32 | 48 | 36 |
| Sr ppm | 89 | 90 | 105 | 103 | 102 | 104 | 101 | 99 | 102 |
| Ti % | 0.68 | 0.66 | 0.71 | 0.92 | 0.77 | 0.37 | 0.78 | 0.73 | 0.72 |
| V ppm | 65 | 65 | 71 | 74 | 73 | 73 | 76 | 69 | 72 |
| Zn ppm | 16040 | 15830 | 90 | 82 | 82 | 84 | 86 | 84 | 80 |
| Zr ppm | 950 | 890 | 850 | 900 | 1000 | 910 | 990 | 1020 | 990 |

Table 5c. Unweighted analytical data for standards used in heavy mineral analysis.

YAVA GRID SURVEY 1990 SAMPLE SPLITS

| | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag ppm | 2.5 | 0.3 | 0.5 | 1.0 | 21.5 | 21.0 | 0.3 | 4.0 | 0.3 | 0.3 | 0.3 | 0.3 |
| Al % | 4.03 | 4.05 | 3.56 | 3.63 | 3.06 | 3.12 | 5.68 | 4.92 | 4.74 | 4.81 | 5.26 | 5.30 |
| Ba ppm | 25980 | 25880 | 19480 | 18790 | 11220 | 9740 | 250 | 230 | 220 | 240 | 6660 | 7100 |
| Ca % | 3.57 | 3.59 | 3.07 | 3.16 | 1.60 | 1.59 | 4.45 | 3.91 | 0.81 | 0.76 | 3.25 | 3.26 |
| Cd ppm | 163.0 | 165.0 | 128.5 | 128.5 | 9.0 | 10.0 | 2.5 | 2.5 | 0.3 | 0.3 | 51.0 | 49.0 |
| Co ppm | 28 | 27 | 40 | 39 | 19 | 18 | 18 | 16 | 10 | 10 | 49 | 48 |
| Cr ppm | 79 | 80 | 66 | 80 | 134 | 119 | 145 | 198 | 280 | 20 | 151 | 237 |
| Cu ppm | 217 | 234 | 221 | 233 | 53 | 61 | 52 | 46 | 1 | 1 | 23 | 26 |
| Fe % | 20.93 | 21.63 | 22.63 | 22.75 | 16.13 | 16.86 | 19.22 | 23.08 | 4.47 | 3.78 | 20.14 | 19.25 |
| K % | 0.44 | 0.41 | 0.36 | 0.38 | 0.40 | 0.42 | 0.42 | 0.32 | 1.18 | 1.16 | 0.41 | 0.41 |
| Mg % | 0.67 | 0.68 | 0.59 | 0.57 | 0.43 | 0.43 | 0.77 | 0.71 | 0.43 | 0.43 | 0.82 | 0.83 |
| Mn ppm | 4165 | 4265 | 3680 | 3715 | 3300 | 3340 | 5195 | 5015 | 715 | 630 | 36225 | 35080 |
| Mo ppm | 6 | 10 | 11 | 10 | 7 | 5 | 10 | 8 | 1 | 1 | 10 | 8 |
| Na % | 0.22 | 0.21 | 0.21 | 0.17 | 0.15 | 0.16 | 0.27 | 0.19 | 1.57 | 1.57 | 0.28 | 0.31 |
| Ni ppm | 50 | 48 | 54 | 59 | 19 | 16 | 30 | 29 | 13 | 8 | 26 | 25 |
| P ppm | 920 | 1060 | 400 | 720 | 4440 | 7510 | 1710 | 3880 | 310 | 290 | 2570 | 2260 |
| Pb ppm | 14780 | 16110 | 14640 | 13160 | 44770 | 41710 | 3970 | 3580 | 130 | 92 | 22560 | 21020 |
| Sr ppm | 252 | 213 | 302 | 347 | 157 | 163 | 394 | 334 | 134 | 133 | 287 | 304 |
| Ti % | 3.18 | 3.27 | 3.24 | 3.14 | 3.18 | 2.82 | 5.52 | 8.07 | 1.14 | 0.96 | 6.11 | 5.63 |
| V ppm | 196 | 193 | 188 | 205 | 157 | 152 | 304 | 310 | 77 | 66 | 215 | 234 |
| Zn ppm | 15200 | 16170 | 11690 | 11360 | 1875 | 2080 | 1240 | 1065 | 54 | 54 | 6090 | 5790 |
| Zr ppm | 1280 | 1500 | 11300 | 889 | 1300 | 1650 | 9280 | 21500 | 450 | 300 | 14900 | 9300 |
| W2 | 409.2 | 409.2 | 482.5 | 482.5 | 400.0 | 400.0 | 400.0 | 400.0 | 311.9 | 311.9 | 451.8 | 451.8 |
| W1 | 4.590 | 4.590 | 3.353 | 3.353 | 3.807 | 3.807 | 1.852 | 1.852 | 19.861 | 19.861 | 3.423 | 3.423 |

Table 5d. Unweighted analytical data for sample splits used in heavy mineral analysis.

YAVA GRID SURVEY 1990 SAMPLE SPLITS

| | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wt.V. | | | | | | | | | | | | |
| Ag | 0.0280 | 0.0034 | 0.0035 | 0.0070 | 0.2150 | 0.2100 | 0.0015 | 0.0200 | 0.0192 | 0.0192 | 0.0024 | 0.0024 |
| Al | 0.0452 | 0.0454 | 0.0249 | 0.0254 | 0.0306 | 0.0312 | 0.0284 | 0.0246 | 0.3034 | 0.3078 | 0.0421 | 0.0424 |
| Ba | 291.4179 | 290.2962 | 136.3600 | 131.5300 | 112.2000 | 97.4000 | 1.2500 | 1.1500 | 14.0800 | 15.3600 | 53.2800 | 56.8000 |
| Ca | 0.0400 | 0.0403 | 0.0215 | 0.0221 | 0.0160 | 0.0159 | 0.0223 | 0.0196 | 0.0518 | 0.0486 | 0.0260 | 0.0261 |
| Cd | 1.8284 | 1.8508 | 0.8995 | 0.8995 | 0.0900 | 0.1000 | 0.0125 | 0.0125 | 0.0192 | 0.0192 | 0.4080 | 0.3920 |
| Co | 0.3141 | 0.3029 | 0.2800 | 0.2730 | 0.1900 | 0.1800 | 0.0900 | 0.0800 | 0.6400 | 0.6400 | 0.3920 | 0.3840 |
| Cr | 0.8861 | 0.8974 | 0.4620 | 0.5600 | 1.3400 | 1.1900 | 0.7250 | 0.9900 | 17.9200 | 1.2800 | 1.2080 | 1.8960 |
| Cu | 2.4341 | 2.6248 | 1.5470 | 1.6310 | 0.5300 | 0.6100 | 0.2600 | 0.2300 | 0.0640 | 0.0640 | 0.1840 | 0.2080 |
| Fe | 0.2348 | 0.2426 | 0.1584 | 0.1593 | 0.1613 | 0.1686 | 0.0961 | 0.1154 | 0.2861 | 0.2419 | 0.1611 | 0.1540 |
| K | 0.0049 | 0.0046 | 0.0025 | 0.0027 | 0.0040 | 0.0042 | 0.0021 | 0.0016 | 0.0755 | 0.0742 | 0.0033 | 0.0033 |
| Mg | 0.0075 | 0.0076 | 0.0041 | 0.0040 | 0.0043 | 0.0043 | 0.0039 | 0.0036 | 0.0275 | 0.0275 | 0.0066 | 0.0066 |
| Mn | 46.7188 | 47.8405 | 25.7600 | 26.0050 | 33.0000 | 33.4000 | 25.9750 | 25.0750 | 45.7600 | 40.3200 | 289.8000 | 280.6400 |
| Mo | 0.0673 | 0.1122 | 0.0770 | 0.0700 | 0.0700 | 0.0500 | 0.0500 | 0.0400 | 0.0640 | 0.0640 | 0.0800 | 0.0640 |
| Na | 0.0025 | 0.0024 | 0.0015 | 0.0012 | 0.0015 | 0.0016 | 0.0014 | 0.0010 | 0.1005 | 0.1005 | 0.0022 | 0.0025 |
| Ni | 0.5609 | 0.5384 | 0.3780 | 0.4130 | 0.1900 | 0.1600 | 0.1500 | 0.1450 | 0.8320 | 0.5120 | 0.2080 | 0.2000 |
| P | 10.3196 | 11.8900 | 2.8000 | 5.0400 | 44.4000 | 75.1000 | 8.5500 | 19.4000 | 19.8400 | 18.5600 | 20.5600 | 18.0800 |
| Pb | 165.7874 | 180.7060 | 102.4800 | 92.1200 | 447.7000 | 417.1000 | 19.8500 | 17.9000 | 8.3200 | 5.8880 | 180.4800 | 168.1600 |
| Sr | 2.8267 | 2.3892 | 2.1140 | 2.4290 | 1.5700 | 1.6300 | 1.9700 | 1.6700 | 8.5760 | 8.5120 | 2.2960 | 2.4320 |
| Ti | 0.0357 | 0.0367 | 0.0227 | 0.0220 | 0.0318 | 0.0282 | 0.0276 | 0.0404 | 0.0730 | 0.0614 | 0.0489 | 0.0450 |
| V | 2.1985 | 2.1649 | 1.3160 | 1.4350 | 1.5700 | 1.5200 | 1.5200 | 1.5500 | 4.9280 | 4.2240 | 1.7200 | 1.8720 |
| Zn | 170.4985 | 181.3790 | 81.8300 | 79.5200 | 18.7500 | 20.8000 | 6.2000 | 5.3250 | 3.4560 | 3.4560 | 48.7200 | 46.3200 |
| Zr | 14.3578 | 16.8255 | 79.1000 | 6.2230 | 13.0000 | 16.5000 | 46.4000 | 107.5000 | 28.8000 | 19.2000 | 119.2000 | 74.4000 |

Table 5e. Weighted analytical data for sample splits used in heavy mineral analysis.

YAVA GRID SURVEY 1999 FIELD DUPLICATES

| | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag ppm | 4.5 | 5.5 | 0.3 | 0.3 | 0.3 | 0.3 | 21.5 | 11.0 | 0.3 | 14.0 | 0.3 | 0.3 |
| Al % | 6.04 | 5.60 | 5.62 | 5.45 | 5.56 | 5.02 | 3.06 | 4.22 | 4.83 | 3.31 | 4.34 | 4.03 |
| Ba ppm | 230 | 140 | 310 | 1130 | 280 | 140 | 11220 | 320 | 260 | 90 | 170 | 170 |
| Ca % | 4.06 | 3.45 | 3.59 | 2.66 | 4.09 | 3.64 | 1.60 | 1.85 | 3.03 | 1.15 | 3.61 | 3.46 |
| Cd ppm | 3.5 | 6.0 | 14.5 | 26.5 | 6.0 | 10.5 | 9.0 | 5.5 | 5.0 | 6.5 | 1.0 | 1.5 |
| Co ppm | 14 | 16 | 27 | 39 | 30 | 27 | 19 | 34 | 26 | 14 | 7 | 9 |
| Cr ppm | 225 | 301 | 280 | 190 | 239 | 260 | 134 | 472 | 360 | 112 | 95 | 150 |
| Cu ppm | 11 | 63 | 4 | 76 | 80 | 27 | 53 | 77 | 63 | 111 | 2 | 33 |
| Fe % | 17.91 | 19.52 | 17.95 | 20.94 | 19.69 | 15.59 | 16.13 | 18.50 | 19.73 | 21.66 | 18.19 | 16.27 |
| K % | 0.38 | 0.39 | 0.37 | 0.49 | 0.40 | 0.38 | 0.40 | 0.39 | 0.43 | 0.50 | 0.47 | 0.49 |
| Mg % | 0.83 | 0.74 | 0.85 | 0.76 | 0.81 | 0.87 | 0.43 | 0.69 | 0.74 | 0.49 | 0.63 | 0.58 |
| Mn ppm | 4735 | 4475 | 6050 | 11875 | 6490 | 7125 | 3300 | 8485 | 11435 | 3970 | 4370 | 4785 |
| Mo ppm | 4 | 6 | 7 | 15 | 6 | 7 | 7 | 9 | 12 | 10 | 9 | 2 |
| Na % | 0.23 | 0.24 | 0.41 | 0.23 | 0.21 | 0.21 | 0.15 | 0.08 | 0.15 | 0.04 | 0.24 | 0.22 |
| Ni ppm | 29 | 31 | 30 | 36 | 37 | 27 | 19 | 29 | 22 | 14 | 12 | 11 |
| P ppm | 3290 | 2900 | 3280 | 1730 | 3080 | 5610 | 4440 | 1290 | 1260 | 6840 | 680 | 610 |
| Pb ppm | 348 | 548 | 1290 | 2040 | 1335 | 6900 | 44770 | 44880 | 49200 | 36740 | 258 | 526 |
| Sr ppm | 394 | 363 | 332 | 283 | 355 | 263 | 157 | 109 | 275 | 102 | 484 | 489 |
| Ti % | 12.76 | 10.49 | 11.07 | 7.83 | 10.18 | 10.26 | 3.18 | 8.60 | 6.52 | 2.94 | 6.70 | 5.98 |
| V ppm | 297 | 286 | 274 | 275 | 276 | 248 | 157 | 168 | 199 | 113 | 344 | 396 |
| Zn ppm | 506 | 868 | 1280 | 1310 | 1145 | 2020 | 1875 | 1360 | 1415 | 1340 | 258 | 424 |
| Zr ppm | 26000 | 24100 | 30349 | 18850 | 19800 | 20200 | 1300 | 12650 | 7700 | 940 | 6800 | 8000 |
| W2 | 400.0 | 400.0 | 400.0 | 342.4 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 400.0 | 138.2 | 142.5 |
| W1 | 0.988 | 1.270 | 1.060 | 1.143 | 1.062 | 1.631 | 3.807 | 1.442 | 1.356 | 1.555 | 0.562 | 0.503 |

Table 5f. Unweighted analytical data for field duplicates used in heavy mineral analysis.

YAVA GRID SURVEY 1990 FIELD DUPLICATES

| Wt.V. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag | 0.0090 | 0.0165 | 0.0009 | 0.0009 | 0.0009 | 0.0012 | 0.2150 | 0.0440 | 0.0009 | 0.0560 | 0.0012 | 0.0012 |
| Al | 0.0121 | 0.0168 | 0.0169 | 0.0164 | 0.0167 | 0.0201 | 0.0306 | 0.0169 | 0.0145 | 0.0132 | 0.0174 | 0.0161 |
| Ba | 0.4600 | 0.4200 | 0.9300 | 3.3900 | 0.8400 | 0.5600 | 112.2000 | 1.2800 | 0.7800 | 0.3600 | 0.6800 | 0.6800 |
| Ca | 0.0081 | 0.0104 | 0.0108 | 0.0080 | 0.0123 | 0.0146 | 0.0160 | 0.0074 | 0.0091 | 0.0046 | 0.0144 | 0.0138 |
| Cd | 0.0070 | 0.0180 | 0.0435 | 0.0795 | 0.0180 | 0.0420 | 0.0900 | 0.0220 | 0.0150 | 0.0260 | 0.0040 | 0.0060 |
| Co | 0.0280 | 0.0480 | 0.0810 | 0.1170 | 0.0900 | 0.1080 | 0.1900 | 0.1360 | 0.0780 | 0.0560 | 0.0280 | 0.0360 |
| Cr | 0.4500 | 0.9030 | 0.8400 | 0.5700 | 0.7170 | 1.0400 | 1.3400 | 1.8880 | 1.0800 | 0.4480 | 0.3800 | 0.6000 |
| Cu | 0.0220 | 0.1890 | 0.0120 | 0.2280 | 0.2400 | 0.1080 | 0.5300 | 0.3080 | 0.1890 | 0.4440 | 0.0080 | 0.1320 |
| Fe | 0.0358 | 0.0586 | 0.0539 | 0.0628 | 0.0591 | 0.0624 | 0.1613 | 0.0740 | 0.0592 | 0.0866 | 0.0728 | 0.0651 |
| K | 0.0008 | 0.0012 | 0.0011 | 0.0015 | 0.0012 | 0.0015 | 0.0040 | 0.0016 | 0.0013 | 0.0020 | 0.0019 | 0.0020 |
| Mg | 0.0017 | 0.0022 | 0.0026 | 0.0023 | 0.0024 | 0.0035 | 0.0043 | 0.0028 | 0.0022 | 0.0020 | 0.0025 | 0.0023 |
| Mn | 9.4700 | 13.4250 | 18.1500 | 35.6250 | 19.4700 | 28.5000 | 33.0000 | 33.9400 | 34.3050 | 15.8800 | 17.4800 | 19.1400 |
| Mo | 0.0080 | 0.0180 | 0.0210 | 0.0450 | 0.0180 | 0.0280 | 0.0700 | 0.0360 | 0.0360 | 0.0400 | 0.0360 | 0.0080 |
| Na | 0.0005 | 0.0007 | 0.0012 | 0.0007 | 0.0006 | 0.0008 | 0.0015 | 0.0003 | 0.0005 | 0.0002 | 0.0010 | 0.0009 |
| Ni | 0.0580 | 0.0930 | 0.0900 | 0.1080 | 0.1110 | 0.1080 | 0.1900 | 0.1160 | 0.0660 | 0.0560 | 0.0480 | 0.0440 |
| P | 6.5800 | 8.7000 | 9.8400 | 5.1900 | 9.2400 | 22.4400 | 44.4000 | 5.1600 | 3.7800 | 27.3600 | 2.7200 | 2.4400 |
| Pb | 0.6960 | 1.6440 | 3.8700 | 6.1200 | 4.0050 | 27.6000 | 447.7000 | 179.5200 | 147.6000 | 146.9600 | 1.0320 | 2.1040 |
| Sr | 0.7880 | 1.0890 | 0.9960 | 0.8490 | 1.0650 | 1.0520 | 1.5700 | 0.4360 | 0.8250 | 0.4080 | 1.9360 | 1.9560 |
| Ti | 0.0255 | 0.0315 | 0.0332 | 0.0235 | 0.0305 | 0.0410 | 0.0318 | 0.0344 | 0.0196 | 0.0118 | 0.0268 | 0.0239 |
| V | 0.5940 | 0.8580 | 0.8220 | 0.8250 | 0.8280 | 0.9920 | 1.5700 | 0.6720 | 0.5970 | 0.4520 | 1.3760 | 1.5840 |
| Zn | 1.0120 | 2.6040 | 3.8400 | 3.9300 | 3.4350 | 8.0800 | 18.7500 | 5.4400 | 4.2450 | 5.3600 | 1.0320 | 1.6960 |
| Zr | 52.0000 | 72.3000 | 91.0470 | 56.5500 | 59.4000 | 80.8000 | 13.0000 | 50.6000 | 23.1000 | 3.7600 | 27.2000 | 32.0000 |

Table 5g. Weighted analytical data for field duplicates used in heavy mineral analysis.

YAVA GRID SURVEY 1990 BALSAM FIR

| MAP# | 1 | 2 | 3* | 4 | 5 | 6 | 7 | 8* | 9 | 10 | 11* | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 900 N | 1000 N | 930 N | 930 N | 970 N | 1000 N | 750 N | 705 N | 750 N | 750 N | 734 N | 750 N | 784 N |
| LOCATION | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E |
| Cu ppm | 214 | 156 | 252 | 170 | 201 | 170 | 179 | 202 | 142 | 229 | 228 | 168 | 158 |
| Pb ppm | 54 | 52 | 187 | 65 | 47 | 39 | 62 | 45 | 65 | 75 | 79 | 66 | 35 |
| Zn ppm | 2372 | 1901 | 2957 | 1608 | 1846 | 1947 | 2513 | 1900 | 1601 | 2411 | 2569 | 1602 | 1507 |
| Ag ppm | 2.1 | 1.6 | 0.9 | 1.6 | 1.2 | 1.0 | 1.5 | 1.2 | 1.8 | 2.7 | 2.4 | 1.5 | 1.8 |
| Ni ppm | 27 | 21 | 41 | 17 | 15 | 42 | 23 | 27 | 25 | 38 | 43 | 22 | 26 |
| Co ppm | 4 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 5 | 4 | 4 | 5 |
| Mn ppm | 53812 | 24101 | 31634 | 30271 | 32719 | 17410 | 22162 | 13759 | 26968 | 49185 | 32544 | 24677 | 36914 |
| Fe % | 0.22 | 0.15 | 0.24 | 0.20 | 0.11 | 0.12 | 0.17 | 0.20 | 0.15 | 0.21 | 0.22 | 0.15 | 0.14 |
| As ppm | 10 | 11 | 113 | 9 | 4 | 12 | 9 | 2 | 5 | 8 | 36 | 8 | 4 |
| U ppm | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Th ppm | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 2 |
| Sr ppm | 713 | 547 | 1222 | 646 | 632 | 701 | 1290 | 657 | 731 | 958 | 826 | 701 | 512 |
| Cd ppm | 34.6 | 12.7 | 12.4 | 12.7 | 4.1 | 31.5 | 20.4 | 14.2 | 16.4 | 32.7 | 6.6 | 16.0 | 18.5 |
| Sb ppm | 9 | 9 | 871 | 8 | 9 | 6 | 2 | 2 | 6 | 44 | 272 | 10 | 11 |
| V ppm | 6 | 4 | 3 | 6 | 4 | 1 | 5 | 7 | 5 | 7 | 6 | 7 | 4 |
| Ca % | 17.37 | 14.67 | 25.63 | 22.20 | 18.68 | 15.97 | 24.84 | 13.26 | 20.19 | 19.45 | 13.07 | 22.20 | 15.90 |
| P % | 4.784 | 8.172 | 3.620 | 3.932 | 7.047 | 3.880 | 4.450 | 5.667 | 3.913 | 7.770 | 4.558 | 4.894 | 5.290 |
| Cr ppm | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1 | 1 | 5 | 13 | 1 | 1 |
| Mg % | 3.22 | 5.11 | 3.57 | 2.67 | 2.71 | 2.56 | 2.40 | 2.71 | 2.65 | 2.71 | 3.89 | 1.93 | 3.35 |
| Ba ppm | 752 | 1180 | 1775 | 632 | 1520 | 1673 | 436 | 1453 | 364 | 511 | 161 | 1799 | 2508 |
| B ppm | 419 | 379 | 515 | 411 | 381 | 433 | 410 | 477 | 311 | 437 | 474 | 331 | 356 |
| Al % | 0.49 | 0.32 | 0.88 | 0.32 | 0.46 | 0.52 | 0.24 | 0.49 | 0.49 | 0.66 | 0.48 | 0.65 | 0.30 |
| Na % | 0.36 | 0.33 | 0.15 | 0.33 | 0.18 | 0.15 | 0.24 | 0.33 | 0.30 | 0.19 | 0.17 | 0.27 | 0.16 |
| K % | 21.25 | 25.08 | 14.70 | 18.91 | 19.77 | 25.46 | 19.84 | 26.53 | 16.11 | 19.96 | 23.13 | 22.44 | 21.48 |

Table 6a. Analytical data for ashed Balsam Fir from the Yava grid.

YAVA GRID SURVEY 1990 BALSAM FIR

| MAP# | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23● | 24● | 25 | 26● |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 750 N | 720 N | 480 N | 475 N | 500 N | 500 N | 534 N | 500 N | 485 N | 500 N | 250 N | 270 N | 250 N |
| LOCATION | 1250 E | 1400 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 |
| Cu ppm | 129 | 163 | 200 | 219 | 184 | 149 | 181 | 172 | 224 | 137 | 138 | 142 | 135 |
| Pb ppm | 104 | 57 | 73 | 83 | 145 | 118 | 154 | 162 | 63 | 85 | 196 | 120 | 159 |
| Zn ppm | 1520 | 1426 | 1639 | 3245 | 2245 | 1148 | 2786 | 3914 | 2251 | 2033 | 1656 | 2018 | 1382 |
| Ag ppm | 1.5 | 1.8 | 1.8 | 2.6 | 4.1 | 3.5 | 1.8 | 1.6 | 2.8 | 2.5 | 2.6 | 1.8 | 2.6 |
| Ni ppm | 16 | 23 | 36 | 46 | 29 | 19 | 44 | 37 | 24 | 39 | 16 | 16 | 49 |
| Co ppm | 4 | 2 | 3 | 4 | 2 | 1 | 6 | 4 | 3 | 5 | 3 | 2 | 3 |
| Mn ppm | 39227 | 47728 | 44530 | 45486 | 49538 | 70703 | 23055 | 15574 | 54614 | 36717 | 33283 | 26255 | 46312 |
| Fe % | 0.34 | 0.23 | 0.14 | 0.21 | 0.26 | 0.23 | 0.33 | 0.29 | 0.19 | 0.22 | 0.23 | 0.24 | 0.28 |
| As ppm | 2 | 2 | 9 | 13 | 2 | 2 | 52 | 2 | 2 | 6 | 2 | 3 | 2 |
| U ppm | 5 | 5 | 13 | 7 | 7 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 14 |
| Th ppm | 2 | 5 | 3 | 4 | 1 | 4 | 1 | 1 | 3 | 1 | 1 | 2 | 1 |
| Sr ppm | 491 | 563 | 871 | 732 | 960 | 592 | 1024 | 591 | 815 | 647 | 743 | 579 | 477 |
| Cd ppm | 9.9 | 10.7 | 19.3 | 38.2 | 21.1 | 26.2 | 9.9 | 21.8 | 16.3 | 41.0 | 10.9 | 5.6 | 7.1 |
| Sb ppm | 4 | 2 | 8 | 8 | 2 | 11 | 651 | 2 | 8 | 30 | 2 | 5 | 15 |
| V ppm | 12 | 6 | 5 | 5 | 6 | 8 | 9 | 12 | 4 | 5 | 8 | 8 | 12 |
| Ca % | 26.11 | 19.76 | 22.99 | 14.01 | 22.89 | 24.33 | 21.13 | 24.35 | 20.75 | 8.85 | 20.20 | 14.91 | 19.06 |
| P % | 4.447 | 3.648 | 7.997 | 4.047 | 4.951 | 2.679 | 3.940 | 2.801 | 6.936 | 6.436 | 2.894 | 4.104 | 3.851 |
| Cr ppm | 1 | 1 | 1 | 1 | 1 | 1 | 13 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mg % | 1.58 | 2.94 | 2.28 | 2.81 | 3.06 | 1.63 | 4.65 | 2.50 | 2.32 | 4.43 | 3.58 | 3.27 | 1.53 |
| Ba ppm | 2389 | 337 | 1014 | 271 | 276 | 559 | 746 | 290 | 1436 | 460 | 1228 | 500 | 275 |
| B ppm | 324 | 340 | 367 | 337 | 427 | 461 | 449 | 466 | 398 | 335 | 427 | 341 | 366 |
| Al % | 0.24 | 0.58 | 0.53 | 0.58 | 0.56 | 0.50 | 0.80 | 0.47 | 0.45 | 0.68 | 0.43 | 0.56 | 0.36 |
| Na % | 0.12 | 0.10 | 0.25 | 0.32 | 0.31 | 0.14 | 0.27 | 0.20 | 0.27 | 0.19 | 0.20 | 0.28 | 0.15 |
| K % | 13.70 | 13.96 | 19.49 | 20.14 | 14.33 | 17.33 | 20.22 | 15.34 | 20.25 | 24.80 | 16.82 | 19.96 | 15.87 |

Table 6a. Analytical data for ashed Balsam Fir from the Yava grid.

YAVA GRID SURVEY 1990 BALSAM FIR

| MAP# | 27 | 28* | 29 | 30 | 31* | 32* | 33 | 34* | 35* | 36 | 37 | 38 | 39* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 N | 250 N | 250 N | 300 N | 250 N | 0 | 0 | 0 | 0 | 0 | 100 N | 65 N | 0 |
| LOCATION | 250 E | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 900 E | 1175 E |
| Cu ppm | 201 | 205 | 191 | 142 | 127 | 112 | 128 | 121 | 107 | 168 | 136 | 137 | 155 |
| Pb ppm | 117 | 178 | 106 | 58 | 149 | 2798 | 420 | 352 | 1466 | 424 | 307 | 82 | 186 |
| Zn ppm | 2431 | 2577 | 2137 | 1910 | 2233 | 1515 | 1328 | 1705 | 1728 | 1620 | 1922 | 1424 | 1914 |
| Ag ppm | 2.5 | 2.1 | 2.5 | 1.6 | 2.6 | 1.4 | 1.8 | 2.8 | 2.5 | 1.7 | 1.6 | 2.1 | 2.0 |
| Ni ppm | 14 | 44 | 30 | 40 | 26 | 19 | 25 | 22 | 29 | 27 | 24 | 12 | 16 |
| Co ppm | 3 | 4 | 2 | 5 | 4 | 6 | 5 | 5 | 7 | 5 | 6 | 2 | 1 |
| Mn ppm | 38006 | 15476 | 54401 | 28335 | 30547 | 23383 | 42797 | 36391 | 25520 | 35471 | 42940 | 37176 | 47631 |
| Fe % | 0.24 | 0.26 | 0.30 | 0.89 | 0.26 | 1.93 | 1.59 | 1.17 | 1.71 | 1.09 | 1.11 | 0.26 | 0.24 |
| As ppm | 6 | 64 | 9 | 6 | 17 | 7 | 2 | 12 | 23 | 44 | 7 | 2 | 2 |
| U ppm | 5 | 5 | 12 | 5 | 5 | 5 | 5 | 14 | 5 | 5 | 5 | 7 | 5 |
| Th ppm | 3 | 1 | 4 | 3 | 1 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 1 |
| Sr ppm | 559 | 443 | 759 | 486 | 683 | 1223 | 574 | 669 | 609 | 483 | 600 | 428 | 608 |
| Cd ppm | 26.6 | 39.4 | 15.7 | 4.6 | 11.9 | 2.5 | 6.9 | 6.3 | 5.5 | 4.6 | 9.6 | 7.7 | 15.0 |
| Sb ppm | 11 | 885 | 40 | 10 | 6 | 4 | 8 | 6 | 7 | 641 | 14 | 8 | 2 |
| V ppm | 5 | 3 | 7 | 11 | 7 | 23 | 21 | 17 | 27 | 14 | 16 | 7 | 6 |
| Ca % | 21.25 | 15.89 | 16.61 | 12.61 | 16.99 | 12.71 | 16.76 | 16.87 | 10.13 | 19.88 | 13.57 | 20.52 | 17.25 |
| P % | 4.670 | 4.178 | 8.069 | 7.324 | 2.629 | 2.347 | 1.934 | 1.902 | 1.940 | 3.299 | 3.507 | 3.914 | 2.306 |
| Cr ppm | 1 | 7 | 1 | 3 | 1 | 12 | 1 | 1 | 1 | 3 | 15 | 1 | 1 |
| Mg % | 3.48 | 2.56 | 3.20 | 2.73 | 2.95 | 2.43 | 1.66 | 2.50 | 3.24 | 2.21 | 2.37 | 1.88 | 3.24 |
| Ba ppm | 610 | 311 | 746 | 949 | 1873 | 650 | 1613 | 1078 | 732 | 1468 | 670 | 805 | 780 |
| B ppm | 483 | 390 | 377 | 367 | 383 | 249 | 320 | 377 | 324 | 393 | 307 | 365 | 512 |
| Al % | 0.39 | 0.44 | 0.66 | 0.89 | 0.67 | 1.55 | 1.04 | 1.14 | 1.68 | 0.93 | 1.20 | 0.34 | 0.53 |
| Na % | 0.17 | 0.25 | 0.28 | 0.32 | 0.15 | 0.33 | 0.23 | 0.21 | 0.28 | 0.21 | 0.28 | 0.13 | 0.08 |
| K % | 18.08 | 24.00 | 20.28 | 19.57 | 23.30 | 10.43 | 12.98 | 13.54 | 13.12 | 16.53 | 15.31 | 15.76 | 21.70 |

Table 6a. Analytical data for ashed Balsam Fir from the Yava grid.

YAVA GRID SURVEY 1990 BALSAM FIR

| MAP# | 40* | 41 | 42 | 43* | 44* | 45 | 46 | 47* | 48 | 49 | 50 | 51* | 52* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 S | 250 S | 230 S | 250 S | 250 S | 250 S | 250 S | 250 S | 500 S | 508 S | 508 S | 500 S | 500 S |
| LOCATION | 500 W | 250 W | 0 | 250 E | 485 E | 650 E | 900 E | 1175 E | 500 W | 283 W | 12 W | 250 E | 500 E |
| Cu ppm | 150 | 163 | 197 | 185 | 145 | 242 | 114 | 223 | 172 | 160 | 147 | 115 | 176 |
| Pb ppm | 191 | 170 | 145 | 99 | 143 | 126 | 75 | 63 | 68 | 97 | 134 | 122 | 144 |
| Zn ppm | 1868 | 1705 | 2118 | 2132 | 2366 | 2532 | 1161 | 1788 | 1592 | 1807 | 1593 | 1723 | 2713 |
| Ag ppm | 2.9 | 1.7 | 1.3 | 1.9 | 2.6 | 3.6 | 1.5 | 1.4 | 1.9 | 3.5 | 1.5 | 3.1 | 1.5 |
| Ni ppm | 21 | 20 | 13 | 21 | 27 | 36 | 10 | 30 | 18 | 15 | 30 | 14 | 25 |
| Co ppm | 3 | 3 | 1 | 1 | 3 | 3 | 1 | 4 | 3 | 3 | 2 | 3 | 2 |
| Mn ppm | 32450 | 23578 | 39142 | 43328 | 39977 | 57534 | 16606 | 25121 | 33962 | 53517 | 38887 | 45335 | 16276 |
| Fe % | 0.26 | 0.24 | 0.25 | 0.24 | 0.38 | 0.23 | 0.18 | 0.25 | 0.17 | 0.20 | 0.29 | 0.27 | 0.23 |
| As ppm | 2 | 5 | 18 | 5 | 53 | 2 | 5 | 14 | 6 | 2 | 15 | 29 | 4 |
| U ppm | 10 | 5 | 5 | 5 | 11 | 11 | 5 | 5 | 5 | 5 | 5 | 14 | 5 |
| Th ppm | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| Sr ppm | 541 | 750 | 568 | 441 | 1073 | 737 | 556 | 692 | 697 | 673 | 636 | 851 | 1001 |
| Cd ppm | 27.6 | 18.9 | 14.9 | 5.8 | 3.5 | 5.1 | 10.4 | 12.3 | 11.0 | 9.4 | 11.3 | 7.8 | 1.5 |
| Sb ppm | 2 | 8 | 3 | 6 | 527 | 6 | 8 | 7 | 8 | 2 | 54 | 390 | 2 |
| V ppm | 9 | 9 | 7 | 9 | 16 | 12 | 6 | 6 | 6 | 7 | 11 | 6 | 14 |
| Ca % | 19.23 | 24.55 | 21.67 | 22.67 | 22.81 | 18.30 | 25.89 | 21.21 | 14.07 | 17.76 | 20.96 | 25.37 | 12.76 |
| P % | 3.287 | 2.456 | 2.829 | 3.047 | 1.934 | 3.144 | 3.085 | 4.289 | 3.691 | 2.075 | 2.115 | 1.661 | 2.680 |
| Cr ppm | 1 | 1 | 1 | 15 | 1 | 1 | 3 | 1 | 1 | 1 | 11 | 1 | 1 |
| Mg % | 2.57 | 2.71 | 2.73 | 2.66 | 3.39 | 2.82 | 2.34 | 4.05 | 2.85 | 2.84 | 2.05 | 2.17 | 4.29 |
| Ba ppm | 484 | 2134 | 1082 | 175 | 645 | 617 | 557 | 904 | 866 | 215 | 492 | 362 | 259 |
| B ppm | 372 | 324 | 382 | 425 | 417 | 516 | 334 | 478 | 386 | 432 | 417 | 371 | 426 |
| Al % | 0.47 | 0.77 | 0.41 | 0.62 | 0.88 | 0.90 | 0.55 | 0.66 | 0.39 | 0.46 | 0.42 | 0.65 | 1.08 |
| Na % | 0.32 | 0.21 | 0.17 | 0.28 | 0.34 | 0.24 | 0.22 | 0.40 | 0.21 | 0.24 | 0.24 | 0.28 | 0.25 |
| K % | 18.38 | 18.38 | 18.57 | 16.32 | 17.69 | 18.61 | 18.15 | 17.69 | 23.04 | 16.76 | 19.23 | 13.02 | 24.02 |

Table 6a. Analytical data for ashed Balsam Fir from the Yava grid.

YAVA GRID SURVEY 1990 BALSAM FIR

| MAP# | 53 | 54* | 55 | 56 | 57* | 58 | 59* | 60 | 61 | 62 |
|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 500 S | 500 S | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S |
| LOCATION | 1000 E | 1175 E | 500 W | 295 W | 0 | 250 E | 470 E | 650 E | 1000 E | 1175 E |
| Cu ppm | 185 | 154 | 145 | 127 | 148 | 168 | 193 | 148 | 141 | 154 |
| Pb ppm | 42 | 132 | 60 | 75 | 97 | 110 | 121 | 124 | 78 | 132 |
| Zn ppm | 1926 | 2144 | 1671 | 1273 | 1923 | 1447 | 2333 | 1319 | 1865 | 1980 |
| Ag ppm | 1.5 | 3.5 | 1.9 | 1.6 | 3.2 | 1.9 | 1.1 | 1.7 | 0.8 | 1.7 |
| Ni ppm | 14 | 22 | 16 | 11 | 13 | 17 | 13 | 22 | 16 | 13 |
| Co ppm | 2 | 4 | 1 | 1 | 2 | 2 | 1 | 3 | 1 | 3 |
| Mn ppm | 33388 | 29369 | 32325 | 42540 | 39870 | 46070 | 32560 | 28544 | 17219 | 36184 |
| Fe % | 0.14 | 0.19 | 0.16 | 0.20 | 0.20 | 0.25 | 0.26 | 0.26 | 0.23 | 0.20 |
| As ppm | 2 | 2 | 12 | 3 | 2 | 9 | 5 | 2 | 8 | 7 |
| U ppm | 5 | 17 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Th ppm | 1 | 1 | 3 | 4 | 1 | 2 | 1 | 1 | 1 | 3 |
| Sr ppm | 604 | 849 | 617 | 416 | 691 | 606 | 1106 | 492 | 717 | 629 |
| Cd ppm | 6.1 | 12.2 | 4.4 | 3.3 | 5.5 | 9.1 | 5.9 | 10.9 | 6.2 | 9.9 |
| Sb ppm | 8 | 2 | 3 | 5 | 2 | 33 | 2 | 4 | 6 | 5 |
| V ppm | 5 | 5 | 6 | 8 | 8 | 12 | 11 | 14 | 10 | 5 |
| Ca % | 21.88 | 22.55 | 17.74 | 19.25 | 23.37 | 23.88 | 26.43 | 22.07 | 25.69 | 18.94 |
| P % | 2.937 | 2.630 | 2.318 | 3.517 | 1.927 | 2.619 | 2.508 | 2.052 | 3.026 | 3.157 |
| Cr ppm | 1 | 1 | 1 | 2 | 1 | 7 | 5 | 1 | 10 | 1 |
| Mg % | 3.50 | 3.41 | 1.74 | 1.72 | 2.03 | 1.59 | 2.48 | 2.08 | 3.05 | 2.94 |
| Ba ppm | 724 | 254 | 402 | 368 | 429 | 413 | 512 | 869 | 350 | 1123 |
| B ppm | 376 | 438 | 406 | 318 | 457 | 528 | 518 | 421 | 434 | 435 |
| Al % | 0.28 | 0.60 | 0.30 | 0.34 | 0.47 | 0.57 | 0.80 | 0.31 | 0.48 | 0.43 |
| Na % | 0.20 | 0.33 | 0.15 | 0.16 | 0.50 | 0.13 | 0.43 | 0.24 | 0.27 | 0.25 |
| K % | 17.81 | 17.82 | 18.43 | 15.24 | 14.70 | 18.58 | 16.57 | 19.63 | 16.97 | 19.48 |

Table 6a. Analytical data for ashed Balsam Fir from the Yava grid.

YAVA GRID SURVEY 1990 BALSAM FIR STANDARDS

|  | CDSTD | CDSTD | CDSTD | CDSTD | CDSTD | CDSTD |
|---|---|---|---|---|---|---|
| Cu ppm | 117 | 152 | 120 | 111 | 109 | 206 |
| Pb ppm | 272 | 402 | 277 | 1528 | 213 | 443 |
| Zn ppm | 1827 | 2045 | 1989 | 1774 | 1748 | 1819 |
| Ag ppm | 13.9 | 14.3 | 14.7 | 13.3 | 13.4 | 13.3 |
| Ni ppm | 18 | 18 | 21 | 16 | 16 | 16 |
| Co ppm | 3 | 3 | 3 | 3 | 3 | 3 |
| Mn ppm | 14471 | 15148 | 14391 | 13876 | 14118 | 14280 |
| Fe % | 1.29 | 1.52 | 1.39 | 1.22 | 0.87 | 1.26 |
| As ppm | 3 | 3 | 6 | 2 | 2 | 5 |
| U ppm | 5 | 5 | 6 | 5 | 5 | 5 |
| Th ppm | 1 | 1 | 1 | 1 | 1 | 1 |
| Sr ppm | 788 | 816 | 845 | 772 | 756 | 748 |
| Cd ppm | 4.8 | 4.7 | 4.5 | 4.9 | 4.2 | 3.7 |
| Sb ppm | 4 | 3 | 6 | 7 | 8 | 4 |
| V ppm | 2 | 4 | 2 | 2 | 2 | 2 |
| Ca % | 29.06 | 29.23 | 25.98 | 29.38 | 28.10 | 27.99 |
| P % | 1.006 | 1.086 | 0.870 | 0.944 | 1.081 | 0.961 |
| Cr ppm | 10 | 10 | 8 | 4 | 3 | 3 |
| Mg % | 2.80 | 2.87 | 2.82 | 2.65 | 2.59 | 2.52 |
| Ba ppm | 359 | 351 | 183 | 540 | 561 | 643 |
| B ppm | 304 | 312 | 325 | 297 | 299 | 295 |
| Al % | 0.62 | 0.60 | 0.65 | 0.61 | 0.61 | 0.58 |
| Na % | 0.36 | 0.40 | 0.38 | 0.35 | 0.34 | 0.34 |
| K % | 5.75 | 6.01 | 5.42 | 5.59 | 5.51 | 5.50 |

**Table 6b. Analytical data for standards used in ashed Balsam Fir analysis (courtesy C. Dunn).**

YAVA GRID SURVEY 1990 BALSAM FIR SAMPLE SPLITS

| | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT |
|---|---|---|---|---|---|---|---|---|---|---|
| Cu ppm | 135 | 137 | 170 | 161 | 111 | 248 | 187 | 193 | 129 | 129 |
| Pb ppm | 307 | 307 | 51 | 47 | 43 | 106 | 91 | 80 | 107 | 101 |
| Zn ppm | 1903 | 1941 | 1015 | 959 | 1122 | 2181 | 2253 | 2502 | 1514 | 1525 |
| Ag ppm | 1.6 | 1.6 | 1.8 | 1.6 | 1.4 | 2.4 | 2.8 | 0.2 | 1.3 | 1.6 |
| Ni ppm | 27 | 20 | 19 | 16 | 21 | 32 | 43 | 29 | 16 | 16 |
| Co ppm | 7 | 4 | 4 | 4 | 7 | 8 | 7 | 3 | 4 | 4 |
| Mn ppm | 42965 | 42915 | 29218 | 28167 | 7845 | 18391 | 25816 | 27771 | 39744 | 38710 |
| Fe % | 1.10 | 1.12 | 0.52 | 0.50 | 0.87 | 1.33 | 0.85 | 0.50 | 0.44 | 0.23 |
| As ppm | 9 | 5 | 12 | 6 | 8 | 10 | 10 | 2 | 2 | 2 |
| U ppm | 5 | 5 | 5 | 5 | 5 | 14 | 12 | 5 | 5 | 5 |
| Th ppm | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 3 |
| Sr ppm | 596 | 608 | 532 | 499 | 300 | 590 | 601 | 694 | 492 | 489 |
| Cd ppm | 9.3 | 9.9 | 6.8 | 6.8 | 3.0 | 5.4 | 4.8 | 1.4 | 9.7 | 10.1 |
| Sb ppm | 9 | 18 | 54 | 18 | 12 | 22 | 33 | 11 | 2 | 5 |
| V ppm | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 2 |
| Ca % | 13.29 | 13.75 | 28.21 | 25.78 | 16.41 | 33.97 | 17.80 | 18.43 | 26.63 | 25.59 |
| P % | 3.448 | 3.565 | 2.556 | 2.409 | 2.650 | 7.147 | 4.992 | 4.229 | 4.413 | 4.480 |
| Cr ppm | 15 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mg % | 2.37 | 2.37 | 2.00 | 2.00 | 1.99 | 4.27 | 2.40 | 2.64 | 1.59 | 1.57 |
| Ba ppm | 628 | 711 | 1194 | 1200 | 1903 | 290 | 832 | 3683 | 2421 | 2356 |
| B ppm | 304 | 309 | 307 | 297 | 218 | 430 | 376 | 422 | 321 | 326 |
| Al % | 1.20 | 1.20 | 0.66 | 0.63 | 0.84 | 1.42 | 1.10 | 0.98 | 0.28 | 0.20 |
| Na % | 0.27 | 0.28 | 0.61 | 0.64 | 0.21 | 0.48 | 0.14 | 0.07 | 0.11 | 0.12 |
| K % | 15.22 | 15.39 | 15.74 | 15.19 | 11.73 | 26.69 | 15.82 | 16.95 | 13.30 | 14.09 |

Table 6c. Analytical data for sample splits used in ashed Balsam Fir analysis.

YAVA GRID SURVEY 1990 BALSAM FIR FIELD DUPLICATES

| | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. | SAMPLE | DUP. |
|---|---|---|---|---|---|---|---|---|
| Cu ppm | 174 | 178 | 141 | 138 | 201 | 211 | 122 | 151 |
| Pb ppm | 98 | 96 | 78 | 62 | 89 | 68 | 22 | 24 |
| Zn ppm | 1633 | 1602 | 1341 | 1392 | 2059 | 2227 | 1583 | 1696 |
| Ag ppm | 2.2 | 1.6 | 2.1 | 2.4 | 2.7 | 3.5 | 1.3 | 1.7 |
| Ni ppm | 27 | 21 | 24 | 22 | 38 | 44 | 18 | 21 |
| Co ppm | 3 | 3 | 5 | 3 | 3 | 4 | 3 | 3 |
| Mn ppm | 24723 | 20055 | 21624 | 22277 | 48279 | 34659 | 24169 | 35129 |
| Fe % | 0.44 | 0.32 | 0.94 | 0.59 | 0.33 | 0.41 | 0.21 | 0.23 |
| As ppm | 8 | 41 | 10 | 12 | 21 | 6 | 3 | 16 |
| U ppm | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Th ppm | 2 | 1 | 3 | 2 | 1 | 1 | 3 | 3 |
| Sr ppm | 497 | 535 | 389 | 434 | 587 | 446 | 534 | 555 |
| Cd ppm | 6.1 | 17.3 | 8.0 | 9.2 | 16.6 | 11.2 | 2.7 | 2.5 |
| Sb ppm | 12 | 417 | 13 | 13 | 357 | 7 | 8 | 125 |
| V ppm | 19 | 11 | 20 | 12 | 3 | 9 | 4 | 5 |
| Ca % | 22.52 | 21.99 | 18.70 | 19.52 | 20.69 | 18.48 | 17.46 | 18.08 |
| P % | 4.050 | 4.043 | 4.001 | 4.180 | 4.563 | 5.470 | 3.671 | 3.654 |
| Cr ppm | 2 | 13 | 6 | 2 | 1 | 1 | 1 | 8 |
| Mg % | 1.82 | 1.98 | 2.61 | 2.73 | 2.91 | 3.06 | 2.09 | 2.62 |
| Ba ppm | 342 | 253 | 422 | 319 | 3224 | 597 | 794 | 479 |
| B ppm | 309 | 304 | 262 | 283 | 426 | 412 | 295 | 330 |
| Al % | 0.67 | 0.54 | 0.81 | 0.64 | 0.71 | 0.73 | 0.51 | 0.44 |
| Na % | 0.27 | 0.23 | 0.22 | 0.17 | 0.11 | 0.18 | 0.12 | 0.09 |
| K % | 12.26 | 14.94 | 11.15 | 13.76 | 18.38 | 16.59 | 16.64 | 15.46 |

Table 6d. Analytical data for field duplicates used in ashed Balsam Fir analysis.

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 900 N | 930 N | 930 N | 970 N | 1000 N | 750 N | 705 N | 750 N | 750 N | 734 N | 750 N |
| LOCATION | 0 | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E |
| Cu ppm | 6 | 3 | 5 | 9 | 5 | 8 | 3 | 4 | 10 | 8 | 12 |
| Pb ppm | 38 | 33 | 22 | 66 | 66 | 216 | 22 | 43 | 56 | 62 | 290 |
| Zn ppm | 32 | 21 | 40 | 50 | 46 | 72 | 30 | 48 | 29 | 68 | 71 |
| Ag ppm | 1.8 | 2.4 | 1.4 | 1.4 | 0.8 | 0.3 | 0.3 | 2.7 | 0.8 | 2.0 | 3.1 |
| Ni ppm | 5 | 1 | 1 | 4 | 4 | 12 | 3 | 3 | 4 | 4 | 6 |
| Co ppm | 3 | -1 | -1 | -1 | 1 | 8 | -1 | -1 | 7 | -1 | 36 |
| Mn % | 0.020 | 0.010 | 0.003 | 0.160 | 0.010 | 0.200 | 0.006 | 0.020 | 0.060 | 0.030 | 0.820 |
| Fe Tot % | 0.81 | 0.19 | 0.16 | 0.34 | 0.38 | 1.01 | 0.20 | 0.19 | 0.82 | 0.24 | 6.47 |
| As ppm | -5 | -5 | -5 | -5 | -5 | 12 | -5 | -5 | 10 | 8 | 7 |
| Sr ppm | 13 | 10 | 17 | 16 | 11 | 68 | 17 | 20 | 6 | 23 | 4 |
| Cd ppm | 1.0 | -0.2 | -0.2 | 0.3 | 1.0 | 1.5 | 0.7 | 0.7 | -0.2 | 0.4 | -0.2 |
| V ppm | 13 | 4 | 2 | 9 | 8 | 12 | 5 | 5 | 8 | 8 | 30 |
| Ca % | 0.11 | 0.16 | 0.12 | 0.27 | 0.09 | 0.52 | 0.19 | 0.26 | 0.05 | 0.30 | 0.04 |
| Sc ppm | 74 | 61 | 61 | 14 | 66 | 21 | 79 | 71 | 13 | 10 | 177 |
| Cr ppm | 5 | 1 | -1 | 3 | 3 | 14 | 2 | 2 | 4 | 3 | 31 |
| Mg % | 0.05 | 0.03 | 0.04 | 0.07 | 0.03 | 0.11 | 0.03 | 0.05 | 0.03 | 0.09 | 0.07 |
| Ba ppm | 128 | 19 | 22 | 50 | 86 | 215 | 65 | 49 | 53 | 57 | 54 |
| Al % | 0.33 | 0.05 | 0.07 | 0.10 | 0.21 | 0.43 | 0.06 | 0.07 | 0.35 | 0.06 | 3.43 |
| Na % | 0.02 | 0.01 | 0.00 | -0.01 | 0.02 | 0.02 | -0.01 | 0.01 | -0.01 | -0.01 | 0.01 |
| K % | 0.04 | 0.02 | 0.00 | 0.08 | 0.04 | 0.08 | 0.03 | 0.03 | 0.05 | 0.05 | 0.04 |

Table 7a. Analytical data for -80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 784 N | 750 N | 720 N | 480 N | 475 N | 500 N | 500 N | 534 N | 500 N | 485 N | 500 N |
| LOCATION | 1000 E | 1250 E | 1400 E | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E |
| Cu ppm | 8 | 7 | 6 | 4 | 7 | 4 | 6 | 5 | -9 | 8 | IS |
| Pb ppm | 78 | 198 | 103 | 33 | 74 | 71 | 82 | 93 | -9 | 729 | IS |
| Zn ppm | 70 | 181 | 56 | 22 | 70 | 39 | 49 | 52 | -9 | 117 | IS |
| Ag ppm | 2.2 | -0.2 | 1.0 | 0.6 | 0.9 | 3.8 | 0.5 | 2.6 | IS | 2.2 | IS |
| Ni ppm | 4 | 6 | 4 | 3 | 6 | 2 | 4 | 4 | -9 | 2 | IS |
| Co ppm | 2 | 1 | -1 | -1 | 3 | -1 | 2 | 2 | -9 | -1 | IS |
| Mn % | 0.020 | 0.010 | 0.040 | 0.009 | 0.110 | 0.020 | 0.030 | 0.007 | -9.000 | 0.030 | IS |
| Fe Tot % | 0.14 | 0.34 | 0.36 | 0.23 | 1.42 | 0.28 | 0.69 | 0.27 | -9.00 | 0.39 | IS |
| As ppm | 7 | -5 | -5 | -5 | 8 | -5 | -5 | -5 | -9 | 6 | IS |
| Sr ppm | 32 | 47 | 27 | 10 | 7 | 15 | 21 | 20 | -9 | 14 | IS |
| Cd ppm | 0.6 | 2.2 | 0.6 | 0.2 | -0.2 | -0.2 | 0.8 | 1.0 | -9.0 | 1.6 | IS |
| V ppm | 3 | 5 | 8 | 6 | 13 | 4 | 4 | 5 | -9 | 7 | IS |
| Ca % | 0.29 | 0.59 | 0.37 | 0.06 | 0.07 | 0.18 | 0.27 | 0.16 | -9.00 | 0.17 | IS |
| Sc ppm | 78 | 14 | 16 | 59 | 38 | 82 | 97 | 45 | -9 | 99 | IS |
| Cr ppm | 3 | 3 | 2 | 2 | 7 | -1 | 3 | -1 | -9 | 1 | IS |
| Mg % | 0.10 | 0.16 | 0.06 | 0.02 | 0.09 | 0.04 | 0.06 | 0.05 | -9.00 | 0.04 | IS |
| Ba ppm | 105 | 322 | 64 | 33 | 33 | 42 | 123 | 109 | -9 | 98 | IS |
| Al % | 0.14 | 0.16 | 0.11 | 0.07 | 0.38 | 0.30 | 0.23 | 0.26 | -9.00 | 0.22 | IS |
| Na % | 0.01 | 0.02 | -0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | -9.00 | -0.01 | IS |
| K % | 0.06 | 0.04 | 0.05 | 0.03 | 0.04 | 0.05 | 0.06 | 0.03 | -9.00 | 0.03 | IS |

Table 7a. Analytical data for -80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 N | 270 N | 250 N | 250 N | 250 N | 250 N | 300 N | 250 N | 0 | 0 | 0 |
| LOCATION | 500 W | 250 W | 0 | 250 E | 500 E | 750 E | 1000 E | 1250 E | 500 W | 250 W | 0 |
| Cu ppm | 6 | 9 | IS | 4 | 6 | 3 | 1 | 5 | 5 | 5 | 7 |
| Pb ppm | 40 | 165 | IS | 73 | 2186 | 44 | 95 | 1027 | 382 | 55 | 98 |
| Zn ppm | 100 | 52 | IS | 42 | 306 | 20 | 44 | 176 | 62 | 30 | 75 |
| Ag ppm | 1.9 | 3.3 | IS | 1.0 | 2.4 | 1.0 | 0.9 | 5.1 | 3.8 | 1.5 | 4.3 |
| Ni ppm | 4 | 5 | IS | 3 | 5 | 2 | -1 | 3 | 4 | 2 | 5 |
| Co ppm | -1 | 2 | IS | -1 | 3 | -1 | -1 | -1 | 1 | -1 | 1 |
| Mn % | 0.020 | 0.003 | IS | 0.010 | 0.120 | 0.020 | 0.002 | 0.008 | 0.050 | 0.010 | 0.040 |
| Fe Tot % | 0.13 | 0.45 | IS | 0.30 | 1.17 | 0.19 | 0.97 | 0.19 | 0.38 | 0.16 | 0.23 |
| As ppm | -5 | 7 | IS | -5 | -5 | -5 | -5 | -5 | 1 | -5 | -5 |
| Sr ppm | 35 | 5 | IS | 13 | 7 | 14 | 1 | 22 | 52 | 20 | 31 |
| Cd ppm | 0.7 | 1.2 | IS | 0.3 | 1.3 | -0.2 | -0.2 | 2.1 | 0.0 | 0.6 | 0.5 |
| V ppm | 5 | 5 | IS | 7 | 13 | 3 | 10 | 2 | 5 | 5 | 7 |
| Ca % | 0.21 | 0.05 | IS | 0.07 | 0.12 | 0.13 | 0.01 | 0.11 | 0.25 | 0.17 | 0.42 |
| Sc ppm | 74 | 6 | IS | 42 | 71 | 65 | 56 | 57 | 46 | 21 | 120 |
| Cr ppm | 2 | 2 | IS | 3 | 6 | -1 | 2 | -1 | 3 | 2 | 4 |
| Mg % | 0.09 | 0.04 | IS | 0.05 | 0.09 | 0.04 | 0.04 | 0.05 | 0.08 | 0.08 | 0.09 |
| Ba ppm | 58 | 33 | IS | 33 | 94 | 30 | 6 | 233 | 193 | 98 | 80 |
| Al % | 0.10 | 0.60 | IS | 0.14 | 0.71 | 0.05 | 0.26 | 0.16 | 0.15 | 0.06 | 0.11 |
| Na % | 0.02 | -0.01 | IS | 0.02 | 0.01 | -0.01 | -0.01 | 0.01 | 0.00 | 0.01 | 0.03 |
| K % | 0.03 | 0.04 | IS | 0.03 | 0.04 | 0.02 | 0.01 | 0.04 | 0.03 | 0.03 | 0.04 |

Table 7a. Analytical data for -80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 0 | 0 | 100 N | 65 N | 0 | 250 S | 250 S | 230 S | 250 S | 250 S | 250 S |
| LOCATION | 250 E | 500 E | 750 E | 900 E | 1175 E | 500 W | 250 W | 0 | 250 E | 485 E | 650 E |
| Cu ppm | 5 | 5 | 4 | IS | 5 | 9 | 12 | 7 | 5 | 10 | 6 |
| Pb ppm | 167 | 123 | 122 | IS | 53 | 77 | 144 | 56 | 77 | 49 | 55 |
| Zn ppm | 38 | 33 | 49 | IS | 59 | 72 | 54 | 48 | 58 | 105 | 49 |
| Ag ppm | 6.3 | 5.9 | 3.1 | IS | 1.9 | 5.3 | 2.1 | 1.5 | 2.3 | 4.3 | 0.9 |
| Ni ppm | 2 | 3 | 2 | IS | 3 | 5 | 4 | 3 | 2 | -1 | 4 |
| Co ppm | -1 | -1 | -1 | IS | -1 | 2 | 1 | -1 | -1 | -1 | -1 |
| Mn % | 0.008 | 0.010 | 0.020 | IS | 0.020 | 0.030 | 0.006 | 0.010 | 0.005 | 0.004 | 0.030 |
| Fe Tot % | 0.25 | 0.27 | 0.49 | IS | 0.17 | 0.30 | 0.40 | 0.17 | 0.32 | 0.12 | 0.17 |
| As ppm | -5 | 6 | -5 | IS | 6 | -5 | -5 | -5 | -5 | -5 | 7 |
| Sr ppm | 19 | 16 | 11 | IS | 28 | 18 | 19 | 16 | 4 | 30 | 13 |
| Cd ppm | -0.2 | 0.4 | -0.2 | IS | -0.2 | 0.5 | 0.3 | 0.4 | -0.2 | 0.8 | -0.2 |
| V ppm | 3 | 5 | 7 | IS | 4 | 9 | 4 | 5 | 3 | 1 | 5 |
| Ca % | 0.08 | 0.25 | 0.12 | IS | 0.16 | 0.31 | 0.19 | 0.22 | 0.04 | 0.09 | 0.16 |
| Sc ppm | 55 | 9 | 66 | IS | 69 | 99 | 33 | 8 | 45 | 53 | 18 |
| Cr ppm | -1 | 3 | 2 | IS | 2 | 6 | 3 | 2 | 1 | -1 | 3 |
| Mg % | 0.08 | 0.07 | 0.04 | IS | 0.10 | 0.08 | 0.05 | 0.09 | 0.02 | 0.08 | 0.05 |
| Ba ppm | 43 | 67 | 51 | IS | 73 | 94 | 82 | 28 | 20 | 61 | 29 |
| Al % | 0.12 | 0.08 | 0.17 | IS | 0.07 | 0.08 | 0.58 | 0.07 | 1.04 | 0.08 | 0.06 |
| Na % | 0.01 | -0.01 | -0.01 | IS | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 | -0.01 |
| K % | 0.03 | 0.04 | 0.05 | IS | 0.06 | 0.05 | 0.05 | 0.04 | 0.03 | 0.03 | 0.08 |

Table 7a. Analytical data for −80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GRID- | 250 S | 250 S | 500 S | 508 S | 508 S | 500 S | 500 S | 500 S | 500 S | 750 S | 750 S |
| LOCATION | 900 E | 1175 E | 500 W | 283 W | 12 W | 250 E | 500 E | 1000 E | 1175 E | 500 W | 295 W |
| Cu ppm | 4 | 4 | 8 | 8 | 3 | 8 | 10 | 7 | 5 | 9 | 6 |
| Pb ppm | 37 | 42 | 63 | 74 | 36 | 28 | 77 | 43 | 62 | 80 | 88 |
| Zn ppm | 35 | 55 | 42 | 91 | 41 | 72 | 45 | 53 | 53 | 52 | 69 |
| Ag ppm | 0.9 | 1.2 | 0.7 | 1.1 | 1.4 | 1.6 | 1.7 | 2.2 | 1.3 | 0.9 | 0.4 |
| Ni ppm | -1 | 1 | 7 | 3 | -1 | 2 | 4 | 2 | -1 | 4 | 3 |
| Co ppm | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Mn % | 0.010 | 0.006 | 0.035 | 0.030 | 0.010 | 0.002 | 0.004 | 0.020 | 0.008 | 0.020 | 0.050 |
| Fe Tot % | 0.19 | 0.23 | 0.23 | 0.17 | 0.11 | 0.06 | 0.17 | 0.16 | 0.17 | 0.28 | 0.19 |
| As ppm | -5 | -5 | 1 | -5 | 6 | -5 | -5 | -5 | -5 | 9 | -5 |
| Sr ppm | 19 | 24 | 16 | 38 | 33 | 35 | 25 | 23 | 47 | 25 | 23 |
| Cd ppm | -0.2 | 0.3 | -0.2 | 0.3 | -0.2 | 0.6 | 1.7 | -0.2 | -0.2 | 0.4 | 0.7 |
| V ppm | 3 | 3 | 6 | 6 | -1 | 2 | 4 | 3 | 3 | 7 | 5 |
| Ca % | 0.09 | 0.12 | 0.20 | 0.22 | 0.18 | 0.18 | 0.09 | 0.24 | 0.44 | 0.17 | 0.19 |
| Sc ppm | 53 | 61 | 33 | 10 | 64 | 16 | 77 | 82 | 87 | 10 | 59 |
| Cr ppm | -1 | -1 | 2 | 2 | -1 | 1 | 4 | 2 | -1 | 3 | 2 |
| Mg % | 0.06 | 0.06 | 0.05 | 0.08 | 0.08 | 0.11 | 0.08 | 0.06 | 0.11 | 0.07 | 0.11 |
| Ba ppm | 37 | 35 | 52 | 160 | 37 | 14 | 52 | 45 | 83 | 66 | 94 |
| Al % | 0.09 | 0.08 | 0.13 | 0.09 | 0.04 | 0.06 | 0.06 | 0.11 | 0.13 | 0.24 | 0.10 |
| Na % | 0.02 | 0.01 | 0.01 | 0.02 | 0.03 | 0.02 | -0.01 | 0.01 | 0.02 | 0.01 | 0.04 |
| K % | 0.04 | 0.03 | 0.07 | 0.04 | 0.03 | 0.03 | 0.05 | 0.06 | 0.03 | 0.05 | 0.05 |

Table 7a. Analytical data for -80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS

| MAP# | 57 | 58 | 59 | 60 | 61 | 62 |
|---|---|---|---|---|---|---|
| GRID- | 750 S | 750 S | 750 S | 750 S | 750 S | 750 S |
| LOCATION | 0 | 250 E | 470 E | 650 E | 1000 E | 1175 E |
| Cu ppm | 6 | 11 | 6 | 3 | 4 | 8 |
| Pb ppm | 46 | 56 | 73 | 21 | 56 | 70 |
| Zn ppm | 65 | 93 | 64 | 56 | 70 | 83 |
| Ag ppm | 0.2 | 0.7 | 0.4 | 0.5 | 1.4 | 2.4 |
| Ni ppm | 3 | 4 | 4 | 2 | 3 | 3 |
| Co ppm | -1 | -1 | -1 | -1 | -1 | -1 |
| Mn % | 0.009 | 0.050 | 0.020 | 0.007 | 0.009 | 0.020 |
| Fe Tot % | 0.16 | 0.22 | 0.23 | 0.21 | 0.18 | 0.20 |
| As ppm | -5 | 8 | 9 | -5 | -5 | 9 |
| Sr ppm | 22 | 15 | 30 | 27 | 24 | 27 |
| Cd ppm | 0.2 | 0.4 | 0.4 | -0.2 | -0.2 | 0.3 |
| V ppm | 5 | 5 | 7 | 2 | 5 | 6 |
| Ca % | 0.24 | 0.21 | 0.26 | 0.35 | 0.30 | 0.33 |
| Sc ppm | 9 | 28 | 15 | 89 | 30 | 22 |
| Cr ppm | 2 | 4 | 3 | -1 | 2 | 3 |
| Mg % | 0.06 | 0.07 | 0.08 | 0.06 | 0.10 | 0.09 |
| Ba ppm | 28 | 24 | 56 | 266 | 23 | 40 |
| Al % | 0.06 | 0.06 | 0.11 | 0.56 | 0.07 | 0.14 |
| Na % | -0.01 | -0.01 | 0.02 | 0.02 | 0.02 | 0.02 |
| K % | 0.04 | 0.08 | 0.05 | 0.02 | 0.05 | 0.05 |

Table 7a. Analytical data for -80 mesh fraction of organic humus ("A" soil horizon).

YAVA GRID SURVEY 1990 HUMUS STANDARDS

| | STD91H | STD91H | STD91H | STD91H | STD91H | STD91H | STD91L | STD91L | STD91L | STD91L | STD91L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cu ppm | 1734 | 1680 | 1669 | 1690 | 1650 | 1566 | 13 | 12 | 14 | 11 | 12 |
| Pb ppm | 1566 | 1555 | 1547 | 1500 | 1543 | 1408 | 23 | 23 | 24 | 19 | 23 |
| Zn ppm | 10213 | 10014 | 10127 | 9968 | 10134 | 9747 | 57 | 57 | 60 | 54 | 55 |
| Ag ppm | 5.4 | 5.5 | 5.9 | 5.1 | 5.3 | 5.5 | 0.4 | -0.2 | -0.2 | 0.3 | -0.2 |
| Ni ppm | 18 | 18 | 16 | 18 | 16 | 16 | 17 | 17 | 18 | 15 | 15 |
| Co ppm | 10 | 10 | 9 | 10 | 10 | 9 | 10 | 10 | 10 | 10 | 9 |
| Mn % | 0.090 | 0.090 | 0.090 | 0.090 | 0.090 | 0.080 | 0.090 | 0.100 | 0.100 | 0.090 | 0.090 |
| Fe Tot % | 3.03 | 2.88 | 2.86 | 2.90 | 2.90 | 2.82 | 2.55 | 2.74 | 2.74 | 2.53 | 2.54 |
| As ppm | 607 | 587 | 622 | 581 | 587 | 566 | 6 | 10 | 10 | 8 | 7 |
| Sr ppm | 15 | 15 | 13 | 14 | 12 | 12 | 16 | 15 | 17 | 14 | 14 |
| Cd ppm | 45.1 | 44.3 | 45.0 | 43.7 | 43.9 | 42.6 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 |
| V ppm | 21 | 21 | 18 | 20 | 18 | 18 | 19 | 19 | 21 | 18 | 18 |
| Ca % | 0.48 | 0.47 | 0.46 | 0.46 | 0.47 | 0.44 | 0.18 | 0.19 | 0.19 | 0.18 | 0.18 |
| Sc ppm | 193 | 203 | 156 | 210 | 238 | 255 | 137 | 188 | 138 | 100 | 110 |
| Cr ppm | 17 | 17 | 13 | 16 | 14 | 14 | 15 | 15 | 16 | 13 | 13 |
| Mg % | 0.39 | 0.37 | 0.36 | 0.37 | 0.37 | 0.36 | 0.36 | 0.38 | 0.38 | 0.35 | 0.36 |
| Ba ppm | 142 | 126 | 111 | 127 | 116 | 108 | 297 | 297 | 362 | 281 | 289 |
| Al % | 1.14 | 1.08 | 1.09 | 1.07 | 1.08 | 1.02 | 0.83 | 0.86 | 0.89 | 0.82 | 0.82 |
| Na % | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 |
| K % | 0.10 | 0.10 | 0.09 | 0.09 | 0.09 | 0.09 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 |

**Table 7b. Analytical data for standards used in the organic humus analysis.**

YAVA GRID SURVEY 1990 HUMUS SAMPLE SPLITS

| | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT | SAMPLE | SPLIT |
|---|---|---|---|---|---|---|---|---|---|---|
| Cu ppm | 8 | 6 | 6 | 6 | 4 | 3 | 7 | 5 | 3 | 7 |
| Pb ppm | 77 | 71 | 38 | 37 | 1571 | 1521 | 91 | 85 | 19 | 25 |
| Zn ppm | 75 | 64 | 30 | 33 | 184 | 191 | 69 | 69 | 29 | 51 |
| Ag ppm | 1.0 | 0.7 | 1.8 | 1.7 | 0.3 | 0.3 | 0.4 | 0.4 | 1.3 | 1.5 |
| Ni ppm | 6 | 5 | 5 | 5 | 5 | 4 | 3 | 2 | -1 | 3 |
| Co ppm | 2 | 3 | 3 | 3 | 6 | 6 | -1 | -1 | -1 | -1 |
| Mn % | 0.110 | 0.110 | 0.020 | 0.020 | 0.190 | 0.200 | 0.050 | 0.050 | 0.002 | 0.003 |
| Fe Tot % | 1.40 | 1.43 | 0.81 | 0.81 | 1.15 | 1.17 | 0.19 | 0.18 | 0.16 | 0.16 |
| As ppm | 9 | 7 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 |
| Sr ppm | 7 | 6 | 13 | 13 | 3 | 2 | 23 | 22 | 16 | 18 |
| Cd ppm | -0.2 | -0.2 | 1.0 | 1.0 | 1.6 | 1.1 | 0.9 | 0.5 | -0.2 | -0.2 |
| V ppm | 13 | 12 | 13 | 13 | 9 | 8 | 6 | 4 | 2 | 2 |
| Ca % | 0.07 | 0.06 | 0.11 | 0.10 | 0.05 | 0.04 | 0.18 | 0.19 | 0.11 | 0.13 |
| Sc ppm | 63 | 12 | 68 | 80 | 74 | 62 | 74 | 43 | 62 | 60 |
| Cr ppm | 8 | 6 | 5 | 4 | 6 | 5 | 3 | 1 | -1 | -1 |
| Mg % | 0.08 | 0.09 | 0.05 | 0.05 | 0.10 | 0.11 | 0.11 | 0.11 | 0.03 | 0.04 |
| Ba ppm | 34 | 32 | 129 | 126 | 61 | 57 | 98 | 89 | 20 | 23 |
| Al % | 0.39 | 0.37 | 0.33 | 0.32 | 0.42 | 0.43 | 0.10 | 0.09 | 0.06 | 0.07 |
| Na % | 0.02 | -0.01 | 0.02 | 0.01 | -0.01 | -0.01 | 0.04 | 0.03 | -0.01 | 0.01 |
| K % | 0.04 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 | 0.05 | 0.05 | -0.01 | 0.01 |

Table 7c. Analytical data for sample splits used in the humus sample analysis.

## YAVA GRID SURVEY 1990 HUMUS FIELD DUPLICATES

| | SAMPLE | DUP. | SAMPLE | DUP. |
|---|---|---|---|---|
| Cu ppm | 4 | 11 | 4 | 6 |
| Pb ppm | 42 | 83 | 404 | 360 |
| Zn ppm | 29 | 54 | 68 | 56 |
| Ag ppm | 0.4 | 1.0 | 4.7 | 2.9 |
| Ni ppm | 9 | 5 | 3 | 4 |
| Co ppm | -1 | -1 | 1 | 1 |
| Mn % | 0.030 | 0.040 | 0.060 | 0.040 |
| Fe Tot % | 0.25 | 0.21 | 0.45 | 0.30 |
| As ppm | -5 | 6 | -5 | 6 |
| Sr ppm | 10 | 21 | 56 | 48 |
| Cd ppm | -0.2 | -0.2 | -0.2 | 0.2 |
| V ppm | 4 | 7 | 5 | 5 |
| Ca % | 0.10 | 0.29 | 0.30 | 0.19 |
| Sc ppm | 55 | 10 | 84 | 8 |
| Cr ppm | -1 | 4 | 2 | 3 |
| Mg % | 0.03 | 0.07 | 0.10 | 0.06 |
| Ba ppm | 37 | 66 | 214 | 171 |
| Al % | 0.08 | 0.18 | 0.17 | 0.12 |
| Na % | -0.01 | 0.02 | 0.01 | -0.01 |
| K % | 0.06 | 0.07 | 0.03 | 0.02 |

Table 7d. Analytical data for field duplicates used in the humus sample analysis.

YAVA STREAM SEDIMENT SURVEY 1990 SILT AND CLAY

| SAMPLE# | 90-001 | 90-002 | 90-003 | 90-004 | 90-005 | 90-006 | 90-007 | 90-008 | 90-009 |
|---|---|---|---|---|---|---|---|---|---|
| Al % | 1.739 | 2.013 | 2.512 | 2.335 | 1.789 | 2.174 | 1.971 | 2.864 | 2.232 |
| Fe TOT. % | 4.08 | 5.20 | 6.26 | 6.99 | 5.99 | 6.81 | 4.40 | 6.00 | 8.85 |
| Mn % | 1.517 | 2.000 | 0.831 | 1.926 | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |
| Mg % | 0.211 | 0.238 | 0.754 | 0.422 | 0.199 | 0.247 | 0.406 | 0.065 | 0.083 |
| Li ppm | 14 | 17 | 29 | 24 | 13 | 19 | 21 | 11 | 8 |
| Sc ppm | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 1 | 2 |
| V ppm | 19 | 22 | 34 | 30 | 22 | 25 | 26 | 11 | 34 |
| Cr ppm | 15 | 17 | 23 | 19 | 13 | 15 | 20 | 7 | 9 |
| Co ppm | 22 | 30 | 32 | 51 | 53 | 59 | 29 | 31 | 49 |
| Ni ppm | 20 | 23 | 36 | 34 | 23 | 39 | 33 | 14 | 11 |
| Cu ppm | 23 | 23 | 13 | 12 | 11 | 13 | 14 | 16 | 11 |
| Zn ppm | 1593 | 1598 | 1205 | 2669 | 1117 | 1641 | 1095 | 601 | 347 |
| As ppm | 22 | 24 | 26 | 28 | -5 | 32 | 14 | 15 | 23 |
| Sr ppm | 13 | 17 | 11 | 14 | 14 | 15 | 17 | 21 | 27 |
| Y ppm | 11 | 12 | 11 | 14 | 12 | 14 | 13 | 5 | 5 |
| Zr ppm | 5 | 5 | 7 | 7 | 3 | 5 | 4 | 5 | 4 |
| Ag ppm | -0.5 | 0.9 | -0.5 | -0.5 | 2.3 | 1.8 | -0.5 | 1.7 | 5.2 |
| Ba ppm | 564 | 864 | 565 | 736 | 812 | 1592 | 530 | 794 | 1363 |
| La ppm | 17 | 22 | 29 | 29 | 23 | 26 | 22 | 13 | 20 |
| Ce ppm | 67 | 82 | 79 | 92 | 73 | 82 | 57 | 54 | 79 |
| Pb ppm | 10000 | 9868 | 2713 | 6454 | 5434 | 4799 | 1775 | 3537 | 1846 |

Table 8. Analytical data for the -230 mesh fraction of stream sediments.

YAVA STREAM SEDIMENT SURVEY 1990 UNWEIGHTED HEAVY MINERALS

| SAMPLE# | 90-001 | 90-002 | 90-003 | 90-004 | 90-005 | 90-006 | 90-007 | 90-008 | 90-009 |
|---|---|---|---|---|---|---|---|---|---|
| Ag ppm | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 3.5 | 0.3 | 0.3 |
| Al % | 5.28 | 5.10 | 6.53 | 6.51 | 6.34 | 5.65 | 6.50 | 5.08 | 4.69 |
| Ba ppm | 6880 | 6840 | 3270 | 3060 | 480 | 9140 | 220 | 5120 | 9660 |
| Ca % | 3.255 | 2.96 | 4.61 | 4.31 | 4.27 | 3.27 | 3.19 | 3.75 | 3.42 |
| Cd ppm | 50 | 51.0 | 28.5 | 47.5 | 18.0 | 40.0 | 58.5 | 12.0 | 2.0 |
| Co ppm | 48.5 | 68 | 29 | 29 | 28 | 55 | 35 | 46 | 52 |
| Cr ppm | 194 | 293 | 369 | 469 | 595 | 400 | 554 | 355 | 258 |
| Cu ppm | 24.5 | 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fe % | 19.695 | 18.42 | 13.28 | 12.49 | 12.24 | 13.25 | 13.40 | 18.81 | 18.04 |
| K % | 0.41 | 0.31 | 0.32 | 0.25 | 0.25 | 0.23 | 0.40 | 0.44 | 0.39 |
| Mg % | 0.825 | 0.75 | 1.53 | 1.20 | 1.09 | 0.93 | 1.45 | 0.66 | 0.54 |
| Mn ppm | 35652.5 | 65135 | 25945 | 33180 | 27635 | 65130 | 9305 | 60320 | 72515 |
| Mo ppm | 9 | 12 | 1 | 2 | 1 | 7 | 1 | 8 | 20 |
| Na % | 0.295 | 0.15 | 0.29 | 0.24 | 0.28 | 0.17 | 0.21 | 0.27 | 0.26 |
| Ni ppm | 25.5 | 22 | 25 | 15 | 21 | 25 | 23 | 24 | 17 |
| P ppm | 2415 | 2860 | 7450 | 7560 | 5060 | 4830 | 3340 | 1370 | 790 |
| Pb ppm | 21790 | 19540 | 1260 | 1325 | 930 | 2440 | 444 | 3030 | 428 |
| Sr ppm | 295.5 | 242 | 296 | 274 | 328 | 230 | 235 | 387 | 382 |
| Ti % | 5.87 | 7.29 | 12.74 | 12.10 | 13.03 | 10.80 | 12.91 | 6.91 | 5.01 |
| V ppm | 224.5 | 195 | 222 | 202 | 221 | 213 | 254 | 353 | 283 |
| Zn ppm | 5940 | 4240 | 3330 | 4910 | 1905 | 2260 | 8100 | 604 | 266 |
| Zr ppm | 12100 | 20000 | 23600 | 29000 | 23500 | 27500 | 33550 | 7000 | 5822 |
| W2 | 451.8 | 451.8 | 426.3 | 400.0 | 400.0 | 472.4 | 340.2 | 103.5 | 104.8 |
| W1 | 3.423 | 3.423 | 1.863 | 1.437 | 1.025 | 1.395 | 0.682 | 0.767 | 1.309 |

Table 9a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

YAVA STREAM SEDIMENT SURVEY 1990 WEIGHTED HEAVY MINERALS

| SAMPLE# | 90-001 | 90-002 | 90-003 | 90-004 | 90-005 | 90-006 | 90-007 | 90-008 | 90-009 |
|---|---|---|---|---|---|---|---|---|---|
| Wt.V. | | | | | | | | | |
| Ag | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0263 | 0.0023 | 0.0023 |
| Al | 0.0396 | 0.0383 | 0.0490 | 0.0488 | 0.0476 | 0.0424 | 0.0488 | 0.0381 | 0.0352 |
| Ba | 51.6000 | 51.3000 | 24.5250 | 22.9500 | 3.6000 | 68.5500 | 1.6500 | 38.4000 | 72.4500 |
| Ca | 0.0244 | 0.0222 | 0.0346 | 0.0323 | 0.0320 | 0.0245 | 0.0239 | 0.0281 | 0.0257 |
| Cd | 0.3750 | 0.3825 | 0.2138 | 0.3563 | 0.1350 | 0.3000 | 0.4388 | 0.0900 | 0.0150 |
| Co | 0.3638 | 0.5100 | 0.2175 | 0.2175 | 0.2100 | 0.4125 | 0.2625 | 0.3450 | 0.3900 |
| Cr | 1.4550 | 2.1975 | 2.7675 | 3.5175 | 4.4625 | 3.0000 | 4.1550 | 2.6625 | 1.9350 |
| Cu | 0.1838 | 0.1650 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 | 0.0075 |
| Fe | 0.1477 | 0.1382 | 0.0996 | 0.0937 | 0.0918 | 0.0994 | 0.1005 | 0.1411 | 0.1353 |
| K | 0.0031 | 0.0023 | 0.0024 | 0.0019 | 0.0019 | 0.0017 | 0.0030 | 0.0033 | 0.0029 |
| Mg | 0.0062 | 0.0056 | 0.0115 | 0.0090 | 0.0082 | 0.0070 | 0.0109 | 0.0050 | 0.0041 |
| Mn | 267.3938 | 488.5125 | 194.5875 | 248.8500 | 207.2625 | 488.4750 | 69.7875 | 452.4000 | 543.8625 |
| Mo | 0.0675 | 0.0900 | 0.0075 | 0.0150 | 0.0075 | 0.0525 | 0.0075 | 0.0600 | 0.1500 |
| Na | 0.0022 | 0.0011 | 0.0022 | 0.0018 | 0.0021 | 0.0013 | 0.0016 | 0.0020 | 0.0020 |
| Ni | 0.1913 | 0.1650 | 0.1875 | 0.1125 | 0.1575 | 0.1875 | 0.1725 | 0.1800 | 0.1275 |
| P | 18.1125 | 21.4500 | 55.8750 | 56.7000 | 37.9500 | 36.2250 | 25.0500 | 10.2750 | 5.9250 |
| Pb | 163.4250 | 146.5500 | 9.4500 | 9.9375 | 6.9750 | 18.3000 | 3.3300 | 22.7250 | 3.2100 |
| Sr | 2.2163 | 1.8150 | 2.2200 | 2.0550 | 2.4600 | 1.7250 | 1.7625 | 2.9025 | 2.8650 |
| Ti | 0.0440 | 0.0547 | 0.0956 | 0.0908 | 0.0977 | 0.0810 | 0.0968 | 0.0518 | 0.0376 |
| V | 1.6838 | 1.4625 | 1.6650 | 1.5150 | 1.6575 | 1.5975 | 1.9050 | 2.6475 | 2.1225 |
| Zn | 44.5500 | 31.8000 | 24.9750 | 36.8250 | 14.2875 | 16.9500 | 60.7500 | 4.5300 | 1.9950 |
| Zr | 90.7500 | 150.0000 | 177.0000 | 217.5000 | 176.2500 | 206.2500 | 251.6250 | 52.5000 | 43.6650 |

Table 9b. Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

MAPS
NOT
FILMED

CARTES
OMISES